AN ASSESSMENT OF CONTEXTUAL DESIGN AND ITS APPLICABILITY TO THE DESIGN OF EDUCATIONAL TECHNOLOGIES

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DEDICATION

To Liz, Hannah, Brian, and Ben.

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ABSTRACT

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Increased use of computing technology in support of learning necessitates the collaboration of instructional designers with technology designers. Yet the instructional designer portrayed in current instructional design textbooks does not participate in technology design but instead designs instructional strategies and materials that are implemented by others. For instructional systems design as a field to move towards the kinds of collaborative work required for the development of effective, innovative educational technologies, there is a need for methods that can integrate the concerns and activities of both instructional and technology designers. This research critically examines a human-computer interaction design method, contextual design (CD), assessing how practitioners employ and characterize it as a method and explores its potential utility in instructional systems design.

CD is briefly described and available evaluative studies are summarized. Next, three studies are presented: a case study of CD usage in the design of a digital music library, a case study of CD integrating with another design approach called PRInCiPleS, and a learning-oriented analysis of CD work models. Based on the findings of the literature review and these three studies, a practitioner survey and interview guide were developed. Results from 106 survey respondents and 16 interviews characterized CD as a guiding framework and a collection of useful techniques. However, because of its resource requirements and other limitations, the method is rarely used in full or exclusively. Respondents reported valuing the ability of CD to uncover and communicate user needs but also suggested CD did not provide a means of resolving conflicts between user needs and organizational objectives.

Implications of these results are explored for three constituencies: developer-designers of instructional places or interactive materials, educators of instructional designers who will work with software developers, and educational researchers and their graduate students.

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1. INTRODUCTION

This dissertation examines a design process from the field of human-computer interaction (HCI) called contextual design (Beyer & Holtzblatt, 1998), and in particular considers the relevance of contextual design (CD) to the field of instructional systems design (ISD). This first chapter explores the growing need for methods in ISD that address the design of interactive systems and argues that CD is worth considering as a candidate method. In support of that argument, CD is briefly described, the literature assessing it is reviewed, and my own experience with the method is set forth. Finally, this chapter maps out the plan for how this collection of studies assesses the usefulness of CD, both overall and potentially for ISD as well.

ISD's Need For Design Methods Addressing Interactive Systems

As the computer has increased in importance as a means of facilitating learning, a new range of design considerations has arisen. These considerations are partly technical and partly organizational. The technical considerations pertain to technology platforms used for instructional delivery and learning environments, but also include the interaction between the users and the technical platforms. Technical platforms, beginning with text-based interaction on terminals and continuing through the development of desktop-metaphor graphical user interfaces and more recently web-based and DVD-based multimedia environments, have offered a rapidly expanding and changing variety of environments and paradigms of interaction available to ISD practitioners. The emergence of handheld and mobile devices, virtual worlds, and 3-D immersive environments makes it clear that this progression shows no sign of slackening. This expansion of computer-based platforms provides an opportunity for ISD as a field to address the full range of design considerations raised by these platforms. This opportunity is particularly enticing in cases where what is being designed are interactive *places* for learning to occur rather than non-interactive *materials* to convey content. Learning materials themselves may be interactive; to the extent they are interactive (e.g., web sites, Flash tutorials), their design and development likewise suggests new methodological opportunities for ISD.

The chief organizational consideration raised by the increased use of computers in learning is the need for instructional designers to work with and influence programmers, who may have little acquaintance with instructional design but who sometimes control the development process. This provides another growth area for ISD, where instructional designers can find and develop methods for working effectively with programmers to ensure strong support for learning.

An example of learning environment design illustrating both technical and organizational considerations is the Sakai project (www.sakaiproject.org). Sakai is a cooperative software development effort among many universities to build a free, open-source, course management system (CMS), one that is responsive to the evolving needs of educational institutions while avoiding the per-user licensing fees charged by vendors such as Blackboard (www.blackboard.com; Wheeler, 2004a, 2004b, 2007). Although Sakai was originally and has continued to be largely driven by information technology (IT) rather than by instructional designers, the “community source development” model pioneered by Sakai offers opportunities for instructional designers to participate in the development of this CMS (Hancock, 2005; McGrath, 2006; Morrone, Goodrum, & Speelmon, 2006). The question arises as to how instructional designers, who may work for a university’s educational technology services organization, can influence the design and development of Sakai to provide a better online learning environment for their faculty and students. Knowledge of instructional design is useful because it provides expert understanding of how an online learning environment supports learning. Yet the software developers creating and improving Sakai do not necessarily have a background in instructional design. Their expertise is predominantly in the area of how to architect and build software applications that work reliably and are maintainable. And these same developers have been, to some level, users themselves because they have been students and may be instructors too. Thus they may be inclined to rely on their own intuitions and preferences for how things should work, particularly in the absence of respected guidance (Gould & Lewis, 1985). But guidance from instructional designers is not necessarily respected by developers because instructional designers may not know the capabilities of the technology well, and they use different but overlapping vocabularies (Grudin, 1991). For instructional designers, effective participation in the Sakai community process may require methods that are usable by programmers and provide bridging communication tools between the two disciplines, tools that support the construction of a shared understanding of user needs, technical capabilities, and design possibilities. Education as a sector may possibly be more susceptible than are some other sectors to developers and their technical management assuming they can use their own experience as a guide to user needs because they all have been students, and some have been instructors as well.

But Sakai is just one example. Other learning environments are constantly under development, whether in the form of other education-oriented open source or commercial CMSs, industry-oriented learning management systems, supplementary textbook websites, discipline-specific course redesign efforts such as those arising from the work of the National Center for Academic Transformation (Twigg, 2003), or learning environments associated with educational research such as TappedIn (Schank, Fenton, Schlager, & Fusco, 1999), Quest Atlantis (Barab, Thomas, Dodge, Carteaux, & Tuzun, 2005), or Learning to Teach with Technology Studio (Malopinsky, Kirkley, Stein, & Duffy, 2000). The creation of each of these places for learning requires a blend of expertise and personnel. Instructional designer participation is important if computer-based places for learning are to fulfill their instructional potential.

A perusal of current instructional design textbooks (e.g., Kemp, Morrison & Ross, 1998; Smith & Ragan, 2005) reveals that the ISD curriculum does not yet include methods for involving instructional designers with programmers on an interdisciplinary team with shared methods and effective bridging communication tools. The instructional designer portrayed in these texts does not generally participate in technology design but instead designs instructional strategies and materials that are implemented by others. Even books specifically addressing the design of web-based learning are not guaranteed to address these needs. For example, Driscoll (2002) describes a “best practice” approach to creating web-based training that identifies, among other roles, a role for instructional designer and a role for programmer, but the book says nothing about who is responsible for ensuring that learners can use the web-based learning successfully. Clark and Mayer (2003) likewise leave the problem of how to design effective web interaction unaddressed. The ISD practitioner must look elsewhere for approaches to technology design that may yield integration of instructional and technology design.

Contextual Design as a Distinguished Example Method

The purpose of this research is to investigate one particular interactive systems design method, CD, and its possible usefulness for the design of educational technologies. CD is an interesting candidate for two reasons. First, CD has been fairly popular and well-regarded in the field of HCI where it evolved. Second, my own experience using CD has been positive (Curtis, Heiserman, Jobusch, Notess, & Webb, 1999), and, as I have moved from information systems design to instructional systems design, I have wanted to take a reflective, critical approach to assessing the utility of CD for the design of educational technologies. CD is not without its critics, and there is no reason to suppose that a method developed for information systems design should transfer unchanged into ISD. This section argues for the legitimacy of selecting CD as a distinguished example by first describing the origin, principles, and steps of CD. Next, a review of the literature demonstrates both the popularity of CD and the studies of CD that are available. This section ends with a description of my own involvement with CD and questions about its applicability to ISD.

Origin

CD began its development at Digital Equipment Corporation in the late 1980s, emerging from the invention of contextual inquiry (CI) by Holtzblatt and Jones (1993; see also Holtzblatt & Beyer, 1993; Holtzblatt, Jones, & Good, 1988). Holtzblatt worked with Beyer to add other techniques to CI to “address the full design process” (Holtzblatt & Beyer, 1993, p. 93, although the outlines of CD are largely discernible in Wixon, Holtzblatt, & Knox, 1990). Holtzblatt and Beyer left Digital Equipment Corporation in the early 1990s to form a consulting company, InContext Enterprises, and write full descriptions of CD, initially in a book chapter (Holtzblatt & Beyer, 1996) and later in the book, *Contextual Design: Defining Customer-Centered Systems* (Beyer & Holtzblatt, 1998). This book continues to be in print 10 years later. More recently, a second CD book has appeared, *Rapid Contextual Design: A How-To Guide to Key Techniques for User-Centered Design* (Holtzblatt, Wendell, & Wood, 2005). This second book still refers to the 1998 publication as the “main” book (p. 22) and offers step-by-step procedures for adapting the CD process by streamlining it. Briefer descriptions of the CD process are available elsewhere (Beyer & Holtzblatt, 1999; Holtzblatt, 2003; Preece, Rogers, & Sharp, 2002).

The CD process is exemplified in detail in later chapters, but a description is provided here of the principles upon which CD is based and of the six steps of the full CD process as described by Beyer and Holtzblatt (1998).

Principles

The principles behind CD can be grouped under three headings: data, the team, and design thinking (pp. 416–421).

The *data* principle is that all design decisions should be grounded "in an explicit, trustworthy understanding" of users and their work (p. 416). CD assumes that users cannot tell designers about their work reliably because much of users' knowledge is tacit, and so a trustworthy understanding has to be discovered through observation of actual work practice in its normal context. Because work practice is complex, data representations must reveal both the details and the patterns in work practice. The CD data principle distinguishes CD from related participatory design methods that bring users into the design process as co-designers, assuming their work knowledge is something they can articulate and contribute to the design process (e.g., Greenbaum & Kyng, 1991; Irestig, Eriksson, & Timpka, 2004).

The *team* principle is that design is usually done by teams of people who need to work together productively. CD is based on the assumption that these team interactions must be purposeful and managed. The externalization of work practice knowledge in diagrams and models, built by the team working together, helps develop the shared understanding required for team productivity, and provides tools whereby the team can communicate their understanding beyond the core team to an extended set of stakeholders in the organization. The step-by-step, cookbook-like quality of CD aspires to scaffold this design-team collaboration.

The *design thinking* principle is that the iterative nature of design needs to be supported by the process. In CD, design consists of cycles of successive refinement, where each step needs validation, an "alternation between doing and reflecting" that "keeps the design moving forward while remaining coherent" (p. 420). This view of design aligns well Schön’s description of design as a reflective “conversation with the materials of a situation” (1983, p. 78).

The Six Steps of Contextual Design

CD comprises six steps. Each step is briefly described below and placed in the context of related techniques. These steps are further described and exemplified in later chapters.

Step 1: Contextual Inquiry. The first step of CD is also its best known technique, CI (Holtzblatt & Jones, 1993). CI is a disciplined approach for observing the work practice of customers (users) while they are doing actual work in their normal working environment. The researcher observes the person working, taking notes on the particular aspects of the work that are of interest in the investigation. While taking notes, the researcher forms interpretations about what is happening and why. Subsequent discussion with the worker provides an opportunity for the researcher to test these interpretations, ascertaining whether they adequately describe and explain the observed behavior.

CI is a fieldwork method similar to ethnography in that it involves going into a culture and describing what is found there. Ethnographic approaches to HCI design are not uncommon (e.g., Nardi, 1996; Simonsen & Kensing, 1997). But CI differs from ethnography in that it is a shorter engagement with any given instance of the culture (contextual interviews usually last only 2 or 3 hours), and, as will be seen in the next step, CI starts with an “a priori framework” for thinking about the data, something ethnography avoids (Nardi, p. 11).

Step 2: Work Modeling. The second step of CD is to take the data gathered with CI and organize it according to five work models and a list of work notes. The five models are diagrams representing the following aspects of work practice.

1. The *flow model* identifies the key roles and responsibilities involved in the work and what moved between them (communication, work products).

2. The *sequence model* captures the actual sequence of steps the user followed, along with what triggered each activity and what the motivating goals and intents were.

3. A *cultural model* shows the power, influences, pressures, and emotions that operated in the user's environment during the observation, impacting the work.

4. *Physical models* depict workplace layout, network topologies, the organization of windows on a computer screen, or anything else in the physical environment relevant to the work of interest.

5. *Artifact* models describe key "things"—artifacts made or used in the course of working, such as a notebook, a bulletin board, or a cheat-sheet.

Examples of each of these models will be shown in the chapters that follow. In the CD process, several members of the design team gather shortly after a CI session has occurred, walking through what was observed step by step while simultaneously creating each of the model types. As these models are being drawn, the team also records each "key observation, insight, influence from the cultural model, question, design idea, and breakdown in the work" as a separate note on a list of "work notes" (Beyer & Holtzblatt, 1998, p. 131). If the members participating in this "interpretation session", as it is called, are part of a larger team, they subsequently hold a "sharing session" to walk through the results of the CI, using the work models to communicate what was observed. After this communication, members of the larger team offer insights, questions, and interpretations, which become annotations to the data.

The CD work models are a unique contribution to design process. No other approach provides such a comprehensive, structured technique for capturing and managing field data about work practice. The closest similar technique might be hierarchical task analysis diagrams, which show the decomposition of a task into steps and substeps (Shepherd, 2001). Hierarchical task analysis diagrams are most similar to CD's sequence model, but they do not capture all the aspects of work represented in the other models.

Also similar to the CD work models is activity theory (Kuutti, 1996), a framework into which the CD models fit at least roughly. Holtzblatt claimed activity theory did not influence the development of CD (K. Holtzblatt, personal communication, January 3, 2007); nevertheless, Nardi's edited volume is listed in the CD book as a "fundamental work" that helps explain CD (Beyer & Holtzblatt, 1998, p. 444). Bertelsen and Bodker (2003) noted that "many ways of bringing activity theory to design have not yet crystallized into formalized techniques or methodical prescriptions" (p. 316), a view shared by other activity-theoretic researchers (e.g., Irestig et al., 2004). Even if CD were not designed as an activity-theoretic toolset, it could serve as one.

Step 3: Consolidation. Taking the results from multiple CI modeling sessions, the design team consolidates each type of model across the different users. For example, all flow models are combined into a single consolidated workflow model. Consolidated models are detailed rather than high-level so that important variations in data across users are not lost. The often-large number of short notes generated during interpretation sessions are consolidated using an affinity diagramming process.

Ethnography has a process similar to consolidation, although it tends not to be diagrammatic or model-based. The ethnographer, for example, may follow a process of open-coding field notes, writing an initial memo, doing more coding, and then writing integrative memos, all of which are primarily textual (Emerson, Fretz, & Shaw, 1995).

Step 4: Work Redesign. Redesign begins with a technique called "walking the wall" (Beyer & Holtzblatt, 1998, p. 275). Consolidated models and the affinity diagram are posted on the wall and used for communicating the work of the design team to a broader audience of stakeholders, from whom additional design ideas and questions are collected. The design team and other stakeholders then create multiple visions for how the work could be improved. A selected vision or visions are developed in some detail with storyboards, which show how the original work story (represented in the consolidated models) is transformed and improved by the new design. The redesign is not just a design of technology, of a program, or of a user interface. It is a redesign of the work practice, the larger system within which the technology operates.

The visioning part of redesign bears similarity to the "fantasy phase" of Kensing and Madsen's "future workshops" (1991), although in CD, end users are less likely to participate.

Step 5. User Environment Design. The user environment design (UED) is a diagrammatic "floor plan" of the system. This system is created directly from the storyboards generated by the previous step. The design team walks through each set of storyboards, creating "places" in the system where users do the work represented in the storyboards. Each place ("focus area," Beyer & Holtzblatt, 1998, p. 306) has a description of its functions, the data it needs, and the links to other functional areas. The collection of focus areas and links between them constitutes a system design from the user experience perspective. Note that the UED is not a complete system design from a programmer's perspective. Rather, it represents the user-visible functionality the complete system needs to support.

The use of diagrams to specify the organization of a system is quite common. For example, the Usage-Centered Design process includes context navigation maps, which express the structure of the user interface (Constantine & Lockwood, 1999). Information architects designing websites often use architectural diagrams or "blueprints" showing the structure and navigation of the website (e.g., Rosenfeld & Morville, 2002).

Step 6. Mock-up and Test with Customers. The design team generates a set of paper prototypes directly from the UED. These low-fidelity prototypes are then taken back into the customer's work context and customers are asked to replay recent work activities using the new system represented in the prototype. Customer reactions to the prototype are used to redesign the prototype *in situ*, providing a basis for a design conversation with users that is grounded in real work. The designers learn from these prototype tests and are able to go back to the design team and make further modifications to the prototypes, the system design, or even to the models if they learn something new about customer work practice.

Iterating with paper prototypes is widely practiced in the HCI community. A recent book focuses exclusively on that topic (Snyder, 2003). In CD the emphasis is on contextual evaluation of prototypes instead of on decontextualized laboratory-based evaluation of prototypes.

The Uniqueness of Contextual Design. There is much in the CD process that was not new when CD was introduced. As noted above, techniques such as ethnography, hierarchical task analysis, activity theory and others bear some resemblance to the steps that comprise CD. Moreover, other design approaches such as joint application design (August, 1991), participatory design (Greenbaum & Kyng, 1991), scenario-based design (Carroll, 1995, 2000), and persona-based design (Pruitt & Adlin, 2006) have addressed similar goals of understanding use and users, and to varying degrees representing and communicating that information to enable cross-functional design team success. The uniqueness of CD lies not so much in its goals or the uniqueness of its specific techniques (although the work models have no real equivalent in other methods). Rather, its distinctiveness lies in the pragmatic combination of multiple techniques into an end-to-end, team-based process grounded in and driven by observation of real work practice.

A Review of Literature Assessing Contextual Design

Contextual design is fairly well-known as an HCI method, but despite this, it has been the subject of relatively little evaluative research. A current HCI textbook devotes more space to CD than to any comparable method (Preece et al., 2002); CD also figures prominently in Kuniavsky's practitioner-oriented methods compendium (2003) and has its own chapter in Jacko and Sears' academically-oriented HCI handbook (Holtzblatt, 2003). CD has been taught and used in the IT industry for over a decade and has been applied to such varied design problems as systems administration, library systems, enterprise portals, and personal document management (Akselbo et al., 2006; Bondarenko & Janssen, 2005; Curtis et al., 1999; Holtzblatt, 2001; Normore, 1999; Rockwell, 1999). The ACM *interactions* magazine devoted an issue to CD, and CD-related tutorials have made frequent appearances at the annual ACM CHI conference. Numerous HCI courses have used Beyer & Holtzblatt (1998) as a text or have had CD-based assignments as part of the class (e.g., Lárusdóttir, 2006; Weinberg & Stephen, 2002).

Given this prominence in industry and education, one might expect researchers to have turned their attention to assessing this method. However, evaluations of CD are somewhat scarce. One form of assessment is to report on a case study of its use (or adapted use), usually followed by a reflection on the method. Others have critiqued CD simply from reading about it. A small number of practitioner surveys have been conducted to assess the extent to which methods including CD or its techniques are used and valued. And finally, one comparative study has been conducted, in which results from CD are compared to results from another method. The sections below summarize each category of study, noting the contribution each makes, if any, to generalizable knowledge about the efficacy of CD. This review concludes with a compilation of some criticisms CD has received in the research literature.

Single-Case Studies. As can be seen from the earlier overview, CD is a six-step process generating many kinds of deliverables. Normal publication venues provide too little space for complete accounts of CD usage. Nevertheless, several case studies have been published (Table 1). Most are *post hoc* accounts of a development project rather than reports of design process research projects. This review of case studies examines in particular which parts of CD were used, how they were used or adapted, and what outcomes were claimed to have resulted from the use of CD techniques. Case studies were included in the review only if they explicitly referenced an intention to apply CD and if the case under study included more than just one CD technique. Excluded, for example, were case studies that used CI to gather data but made no further use of the CD process, or studies that made superficial use of the CD terminology but where the process as documented bore little resemblance to CD (e.g., D'Amico, Hübscher-Younger, Hübscher, & Narayanan, 2003). In 1999, the January issue of the ACM magazine *interactions* featured a special section on Contextual design, guest-edited by Holtzblatt. The issue included three case studies of CD as used in actual development projects. Of these case studies, two (Cleary, 1999; Rockwell, 1999) described use of CD in sufficient detail to include here. Given the identity of the guest editor, it is unsurprising that these case studies place CD in a strongly positive light.

Rockwell (1999) described use of CD techniques to develop a new software product, Ignite-UX, at Hewlett-Packard (HP). The product allowed customers with large numbers of HP Unix systems to manage operating system installation centrally. Nearly all steps of CD were mentioned in this example, and one consolidated flow model was shown. Not mentioned were two of the work models (artifact models and culture model), the affinity diagram, storyboarding, and the user environment design. One adaptation described was the use of remote prototype testing, using online prototypes rather than the paper prototyping preferred by CD. Rockwell provided strong anecdotal evidence of significant benefits, including high customer satisfaction and faster product development, mainly resulting from the high-confidence requirements based on a common understanding of customer work practice. This shared understanding was reported to have eliminated the need for significant reworking of the product, avoided "creeping featurism," and kept the team from being derailed by other requirements arising elsewhere within the company (pp. 55–56). The main contribution of this article is as an illustration of how a user-centered design approach such as CD can help transform development organizations. However, the article provides little critical reflection on the CD process itself.

Table 1
Single-Case Studies Summary

Case Study—Focus	CD Usage Reported	CD Findings
Rockwell (1999)—operating system installation management tool	CI; gathered artifacts, listed insights; flow, sequence, and physical models; model consolidation; work redesign; mock-up and test with customers	high customer satisfaction; reduced rework; faster product development; high-confidence requirements avoided "feature creep" and internal, potentially derailing, influences
Cleary (1999)—network device management	CI; flow and sequence modeling; affinity diagram; consolidation; work redesign	better understanding of customer needs; data presentation can be overwhelming
Curtis et al. (1999)—software support for a new large server product	CI; flow sequence, and physical models; model consolidation (just the flow model); affinity diagram; work redesign	alignment of a large, geographically distributed organization around a shared customer understanding; focus and prioritization for product development; use of data by other teams
Bossen (2002)—hospital software	CI; flow and artifact modeling; work redesign (?)	first-hand experience of work practice; knowledge sharing; shallow customer understanding
Notess (2004a)—digital music library	CI; work modeling; affinity diagram; consolidation; work redesign; mock up and test with customers	uncovers systemic problems reaching beyond the feature set of a particular piece of software; efficient process
Bondarenko & Janssen (2005)—personal document management of information workers	CI; affinity diagram	focus on work activities helps identify commonalities across domains
Vilpola, Väänänen-Vainio-Mattila, & Salmimaa (2006)—ERP implementation	CI; work modeling (all except artifact); consolidation; affinity diagram; work redesign	provides a user-centered design approach to ERP implementation, even with commerical off-the-shelf ERP systems; may be too costly or yield nonrepresentative data

ERP = enterprise resource planning; CI contextual inquiry

A broader, less product-focused study was reported by Cleary (1999), who chronicled a project at Cabletron, a network device company. They conducted a study asking "What does 'device management' mean to a user?" (p. 46). A multidisciplinary team of user experience people, developers, and a quality assurance person conducted many contextual interviews and used data from those interviews to create flow and sequence models as well as collecting notes for an affinity diagram. Once they completed the affinity diagram, but before they consolidated their models, they held an “open house” to share data more broadly in the organization, answer questions, and listen to input and questions. The success of this open house led to 15 other open houses, reaching approximately 150 people throughout the company (p. 47). The team consolidated the flow and sequence models, then invited some additional developers to vision and storyboard with them. The article was written at that point, while team members were still finding ways to influence product development using the work they had done. Cleary’s article does not list benefits of the process, focusing instead on practical ideas for improving their implementation of the process. The main benefit clearly discernible from the article is an improved understanding by many in the company of how their customers think about managing network devices. Cleary quotes one development manager.

> One fact still impresses me. We started out our task to understand device management, but now I think that we have a more fundamental view of the customer that is much different than the one that we had fabricated. Just because our product has a component for device management doesn’t mean that the user breaks up their tasks along the same boundaries. (pp. 47–48)

According to the article, open-house participants were surprised by many of the findings from the study, deepening and correcting their understanding of their customers.

Cleary’s case study does mention one drawback of data representations of CD and how they are used in an organization. People who had not been directly involved in collecting and analyzing the data and were then suddenly presented with a room full of affinity and model data reportedly had trouble making sense of the data and felt “overwhelmed” (p. 49). In response Cleary recommended developing more concise representations.

The same year, Curtis et al. (1999) presented a paper at ACM’s annual Computer-Human Interaction (CHI) conference describing another HP CD project. Curtis et al., described a project aimed at understanding the software needs for a new high-end HP server machine. The article described how a cross-functional, cross-organizational distributed team conducted 40 contextual inquires at seven customer sites, built physical, flow, and sequence models, consolidated the flow models, and then built an affinity diagram out of 1,800 individual notes from customer visits. The focus of the article is on describing techniques for sharing this large amount of customer data with over 200 people across five HP sites and collecting their input and questions. Benefits of CD mentioned in the article are (a) confidence to focus development on a small set of key requirements, and (b) “vision convergence” because of the shared understanding of customers. The authors described how data sharing surfaced a latent “data hunger” in the organization: sites where data sharing and visioning sessions were held wanted to keep the data up on the wall afterwards so they could continue studying it, and data collected for this one project ended up being used by another project team (p. 614). Curtis et al. also reported that customer data sharing led to at least one hardware design modification even though the focus of the project was on software. When the article was written, the work of testing mock-ups with customers was ongoing. One issue the team was unsure how to handle was the large volume of design ideas that were generated during the data sharing. This concern is significant. Stimulating people’s creativity with customer data is usually seen as a positive outcome, but CD does not seem to address the issue of what to do with all the design ideas that do not get used in the redesign step. People who spent time offering those ideas may feel their time was wasted because their ideas were not used.

A more negative case study has been described by Bossen (2002), who examined an application of CD to software for hospitals. Bossen does not describe the case in detail, instead criticizing CD from the perspective of participatory design and ethnography. Nevertheless, his description indicates that the design team conducted contextual inquiries, and analyzed the results using primarily flow and artifact models, but did not do any model consolidation. In addition, one culture model was created. Although Bossen claimed the developers engaged in CD-based work redesign and prototyping, the process he described does not match the CD process. The developers he observed conducted workshops where they expected clinicians themselves to create paper prototypes based on work scenarios developers had created. The result of this process was a set of requirement specifications.

After observing the case, Bossen (2002) noted that the team considered CI and the interpretation sessions to be a valuable means of gaining first-hand experience with the domain and sharing knowledge effectively on the team. The article mainly presented Bossen's own critique rather than the developers' (or customer's) assessment of the process. For example, he asserted that the customer understanding gained through CD is shallow, but gave no examples to elucidate this point.

My case study (Notess, 2004a), published as a book chapter, is detailed in the next chapter of this dissertation. It was intended to begin the process of thinking about how CD applies to the design of educational technologies. The case study portion of that book chapter was mainly descriptive, with the goal of illustrating the CD steps in sufficient detail to support subsequent reflection on CD and ISD. The work for the case study was carried out by students in my Introduction to Human-Computer Interaction graduate class, and the domain of research was online music listening by undergraduate music majors. Each of my students conducted a CI; data from the inquiries were interpreted and modeled; models were consolidated and work notes were organized into an affinity diagram. The affinity diagram and models were shared with the design team of a new digital music library system (of which I was a part) and a visioning exercise was included. Out of this, we did work redesign and storyboarding, eventually building paper prototypes which we later tested with music students. Thus all steps of the process, with the exception of the UED, were carried out as part of this case study. Although this case study did not focus on evaluating CD, there were several benefits mentioned. One claim was that CD provides a holistic view of users' work, often beyond the narrow scope of a particular development project (whether this is a benefit depends on how such findings are used and managed). Also, CD was found to be a fairly quick and efficient process for understanding work practice, generating design ideas, and then iterating the work redesign. The case study mentions no drawbacks to CD, although a more reflective assessment would have pointed out that the case study itself was something of an academic exercise and did not sufficiently involve the actual developers. Because of this, the real outcomes to be assessed should perhaps have been what the students learned as a result of their disconnected participation.

More recently, Bondarenko and Janssen (2005) combined CI and affinity diagramming from CD with other techniques such as artifact walkthroughs and critical incident collection to study personal document management (both paper and online) by information workers. They used CI to study a wide range of information workers over a period of 2 years. They also constructed affinity diagrams from issues identified during the contextual inquiries and their other data gathering. How these activities led to the identification of system requirements is not spelled out in the paper, nor do they explicitly reflect on the efficacy of their chosen research methods. However, they do claim that focusing on work practice (activity) enabled them to factor out commonalities across the wide range of job categories they included in their study.

In the most recent case study report, Vilpola et al. (2006) described an application of CD to Enterprise Resource Planning (ERP) implementation at three companies in Finland. They focused on the order delivery process, conducting CI, building work models (except artifact models), consolidating them, building and affinity diagram from work notes, and redesigning work processes. One adaptation of CD reported was combining the consolidated physical model with the consolidated flow to show how information moved between different departments. The authors concluded that the CD techniques they selected provided an effective way of injecting user-centered design into the ERP implementation process even though the ERP system itself, as a commercial off-the-shelf system, was not being designed as part of this process. They expressed concern that CD was sometimes too costly and that conducting contextual inquiries with certain kinds of people might lead to a "highly personalized perspective" (p. 152). A statement in the article's abstract is revealing, regarding the purpose and intentions of the ERP implementation project: "Three cases demonstrate that the application of CD supports the selection of a suitable system and helps the organization and people adjust their tasks to the new ERP system's processes" (p. 147). Whereas user-centered design methods usually aim at fitting technology to people's needs, this project seems to have aimed at identifying where people and organizations needed to adapt to a technical system. This values reversal may possibly explain why some user data was discounted as "highly personalized."

Practitioner Surveys. A number of methods-oriented HCI practitioner surveys have been conducted over the years, but few of these have asked specifically about CD, or about enough of the techniques that CD comprises, to reveal the extent of adoption or how the process is perceived. For example, Rosenbaum, Rohn, and Humburg (2000) developed a questionnaire covering both usability methods and organizational models of usability. Among the methods listed are CI and, in a survey of 134 practitioners, they found CI to have an average level of usage and perceived effectiveness as compared with other methods. However, the researchers did not investigate any of the other techniques used in CD, nor did they ask about CD usage itself. Vredenburg, Mao, Smith, and Carey (2002) surveyed practitioners, receiving 103 responses and reporting that the category “Field studies (include contextual inquiry)” tied with “User requirements analysis” for the user-centered design method viewed as most important (p. 475). However, with this categorization it is not possible to distinguish CI from other field-study methods.

A practitioner survey limited to Sweden referred explicitly to CD (Gulliksen, Boivie, Persson, Hektor, & Herulf, 2004). Their survey, which drew responses from 194 usability professionals, asked respondents to rate goodness of the methods they had used, including “contextual design” (p. 212). Out of 25 methods listed, CD is not included in the bottom 5 methods, but it is not far above those. The authors did not indicate how many of the respondents reported using CD, nor did they report statistical significance in the differences between the “goodness” ratings of different methods. Instead they reported the percentage of respondents who, having used a method, found it “Very good,” “Fairly good,” and so on. But readers do not know whether these ratings represent 8 people’s use or 80. These gaps make this survey report less helpful than it might otherwise be.

A study by Venturi, Troost, and Jokela (2006) asked 83 user-centered design practitioners what methods they used during different phases of product development. Included in their list were items such as contextual analysis, observations of real usage, and user interviews, which were reported as being used by 42%, 67%, and 80% of the respondents, respectively (p. 225). Presumably user interviews indicates traditional interviewing rather than CI and can be ignored. Observations of real usage could have been CI. Contextual analysis may also have been CI, and could included modeling, but it is impossible to know with certainty what respondents had in mind when choosing these categories even though Venturi intended “contextual analysis” to refer to “contextual inquiry” (G. Venturi, personal communication, July 31, 2007). Other categories relevant to CD included storyboards (42%) and paper or other low fidelity prototyping (75%).

Someone using the full CD process would have difficulty finding categories with which to indicate others of the CD techniques, such as work modeling, affinity diagrams, visioning, and user-environment design.

If nothing else, practitioner surveys indicate that designers of methods surveys do not uniformly address CD in their category creation, nor does CD as a method or its constituent techniques rise to the top when survey data are analyzed. CI may have some prominence, but even that distinction is unclear. It is impossible from existing survey data to determine how broadly CD or CD techniques beyond CI are used or to what extent they are valued when used.

Comparison Case Study. A final category of research examining CD is the comparison case study of which there is only one example. In this category, two or more HCI methods are compared by examining an instance of use. As with the single-case studies above, this section excludes studies only addressing a single technique in CD (e.g., Kantner, Sova, & Rosenbaum, 2003, which only compares a modified form of CI to other techniques).

Jääskö and Mattelmäki (2003) compared the early steps of CD to a probes-based approach in two separate case studies. The goal of the case studies was to assess different methods of "concept design"—the early phases of design where product ideas can be generated or evaluated by exploring customers and their contexts. Both case studies examined hospital environments. The first case study reports how a clinical equipment firm and their industrial design consultants used CI and work modeling to investigate work practice in hospital laboratories. From five contextual inquiries, the team created flow and physical models. They also created cultural and sequence models but explain that they did not follow the CD process to generate these models. What process they did follow is not explained, although they may mean that the models were not tied to specific observations (they mention that some aspects of the work were discussed during the inquiries but were not written down by the researchers). Artifacts were gathered but not modeled.

The second case describes how a patient monitoring equipment firm used design probes to investigate the work context of nurses and gather information particularly about patient transportation. Probe "packages" were created and given to six nurses for about a week of workdays. In each package were “diaries, cameras and illustrated cards with open questions and tasks”; afterward, nurses were interviewed and asked to create a “a collage of an ideal transportation experience from pre-cut pictures and words, and explain it” (p. 129).

Jääskö and Mattelmäki (2003) presented a user experience framework of their own devising to compare how each of the two methods provided design data (see Figure 1, where CD is called “observation”). In this diagram, they used the size of the circle to indicate the amount of data generated by each of the two processes. The top two categories in the diagram (appearance and user interface) are product attributes. The other categories are all intended to represent different aspects of context (p. 127). As a result of their analysis, the authors conclude that the two methods are complementary. A reported advantage of probes was that they provided data from a context where direct observation would have been difficult or not permitted. The diary component of the probes technique was found to provide rich information about feelings, the photos, along with the diaries and interview narratives providing memorable but ambiguous descriptions. CD is seen as missing some of the personal/emotional data but providing a more objective account of work practice. The authors suggested combining the two approaches by starting with probes and following up with observation, particularly if different kinds of work models could be developed to better capture “personal aspects or market context” (Jääskö & Mattelmäki, p. 130).

In their description of the CD case, the authors indicated they found the culture model “vague” (Jääskö & Mattelmäki, 2003, p. 128). Also much of the personal or emotional data that might have informed the culture model was not written down by the researchers. It seems likely that with better training, the researchers using CD might have acquired and represented much more of the data they found lacking in CD. Despite the difficulty the team had in creating some of the models and the apparent lack of any model consolidation, the authors report the research team found the models “very useful” (p. 128). Neither approach was reported to be easy to implement, and in both cases, the authors describe the method as imperfectly executed because of the time and willingness constraints faced by the researchers or the participants.

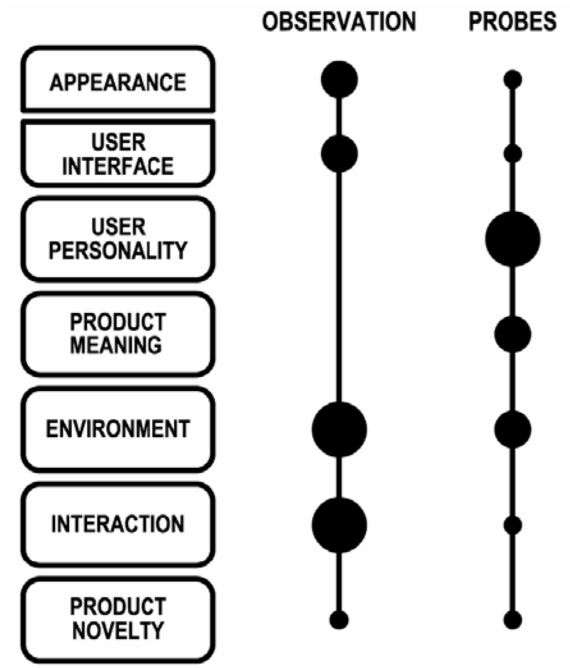


Figure 1. CD vs. probes comparison
From V. Jääskö, T. Mattelmäki, "Observing and Probing," *Proceedings of the 2003 International Conference on Designing Pleasurable Products and Interfaces (DPPI),* p. 130, © 2003 ACM, Inc. Reprinted by permission.

Other Criticisms. CD has received some criticism over the years. Cusumano and Selby, describing early experiences with CD at Microsoft, reported on one Microsoft program manager's perception of CD as ineffective in communicating customer findings outside the core team of customer researchers, time-consuming, and yielding sometimes ambiguous findings (1995, p. 234). Yet others saw CD as too short-term, yielding an "all too brief engagement with users" (Hartswood et al., 2002, p. 283). A benefit of participatory design is that the target organization has an opportunity to learn along with the developers; CD is criticized for failing to provide this opportunity (Herrmann, Kunau, Loser, & Menold, 2004). Certainly CD is not universally used. As discussed above, surveys of methods usage by user-centered design practitioners indicate that CD or its constituent techniques receive some use but are not accepted by everyone. In possible recognition that some practitioners or organizations found the initial CD process too cumbersome, a new book appeared in 2005 providing options for reducing and streamlining CD (Holtzblatt et al., 2005).

Assessing What the Literature Shows. Overall, the published literature describing CD usage or assessing that usage is quite limited. The case studies are perhaps most useful in illustrating the kinds of applications CD to which CD has been put, as well as some of the issues and benefits that might be expected, depending on the context of use. The lack of detailed examples in most of the studies is likely a function of the page limits in most publication venues. A reader interested in, for example, the effectiveness of the model representations has few examples to examine in these cases. With the exception of Jääskö and Mattelmäki (2003), all of the cases lack a detached reflection on the strengths and weaknesses of CD as illustrated in the case. The surveys do not provide a precise enough set of terminology for readers to determine which parts of CD are used, how broadly they are used, or what people who use it value it for.

My Experience

My own experience with CD began when I attended a CHI tutorial on CI in 1991. Several years later I initiated the use of CD in an investigatory project at Hewlett-Packard, where we hired InContext Enterprises to train us on CD. This project had a core team of nearly a dozen people and ran for a period of approximately 3 months. This pilot project resulted in some product ideas and gave the larger organization the confidence to consider using CD in actual product development. We later used CD on several products related to Unix system administration (e.g., Curtis et al., 1999; Rockwell, 1999).

As noted earlier, most CD techniques are not novel. When I brought CD into HP, some (but not all) of the human factors engineers (HFEs) who worked with our organization expressed skepticism at us hiring external consultants to teach us methods with which they were already familiar. They did not see anything new in CD. From the perspective of the developers, however, CD did appear new. Using CD taught us how to gather and use customer data in the design process. In our experience, the skeptical HFEs tended to reserve most of the CD-similar techniques for their own expert use. Because the developers were not involved in gathering and interpreting data, the shared understanding among all those involved in product development was unlikely to occur due to a lack of trust in or awareness of the data.

Since leaving HP, I have continued to apply CD to my work in digital libraries (Notess, 2004a, 2004b, 2005). In my use of CD, I have found myself using the process selectively and incompletely. In particular, I have primarily used CD individually rather than as part of a team that together completed the steps of the process. Even the most light-weight versions of CD "assume a two-person cross-functional core team" (Holtzblatt et al., 2005, p. 40).

Also since leaving HP, I have taught CD as part of a graduate level course introducing students to HCI concepts and methods. Students worked in groups to conduct CI, perform work modeling, consolidation, work redesign, and paper prototyping (skipping the UED step). I offered this course for three semesters, refining the syllabus each time.

In 2004, I started a private discussion forum using Yahoo! groups, devoted to discussing CD. I advertised the group in several HCI-related lists and collected nearly 100 subscribers. Most of the discussion occurred in the first year of the group's existence and now months go by without any postings. This result led me to wonder whether those who learn about CD make use of it, because I would have expected more discussion among practitioners if people were using it. By contrast, another list I participate in, devoted largely to usability testing, has a steady stream of discussion about the practical details of running usability tests.

As I have turned increasingly to educational contexts, I have felt the need to attend to the difference between action-oriented work and learning-oriented work (Quintana, Krajcik, & Soloway, 2000). CD developed in the context of office work—the examples used in the CD book make this clear (Beyer & Holtzblatt, 1998). Although some tasks associated with learning and teaching are certainly office work, there is the additional consideration of learning outcomes. Mayes and Fowler (1999) describe this distinction between usability concerns and learning concerns:

> Learning cannot be approached as a conventional task, as though it were just another kind of work, with a number of problems to be solved and various outputs to be produced. This is because learning is a by-product of doing something else. (p. 485)

One attempt to adapt HCI methods to the needs of educational systems is a set of heuristics for use in evaluating educational software (Squires & Preece, 1999). The authors take a well-established HCI evaluation method, heuristic evaluation (Nielsen, 1994), and modify the list of heuristics to account for the objective of learning. Other writers have likewise explored the relationship between HCI and educational technology development, noting the need for adaptation (Squires, 1999; Notess, 2001). This study aims at extending these explorations.

The Goals, Structure and Benefits of This Research

Goals

The primary goal of this study is to investigate CD by comparing it with other methods and by examining how it is used and characterized by practitioners. A secondary but also important goal is to begin the process of considering how CD might be of use to practitioners of ISD. This secondary goal has implications for ISD practitioners and those who train them.

Structure

To achieve these goals, multiple methods will be used, combining case studies of actual use of CD on projects, structured analysis of a key element of CD (the work models), and a survey of and interviews with HCI practitioners who have learned about CD. The case studies and structured analysis provide a basis for forming theories about the usefulness of CD. The survey and interviews provide one kind of test of those theories. In the end, this entire study with its constituent parts represents progress along a line of research that will require further steps beyond the scope of this study. The progress accomplished by this study is organized into chapters as follows.

Chapter 2: Contextual Design and ISD. This chapter provides a brief overview of ISD and then describes a case study of CD use in the design of the Variations2 Digital Music Library, based on contextual interviews of undergraduate music students. The case study serves to illustrate the CD process with real examples while also considering how well the process seems to work in an ISD-related application. A further contribution of this chapter is to offer preliminary conclusions on how CD might fit with ISD.

Chapter 3: Contextual Design and PRInCiPleS. This chapter further clarifies CD by comparing it with a “design school” design framework, PRInCiPleS, in a case study where the two processes are combined to generate new product ideas for a digital music library. The chapter examines the complementarities and conflicts between these two processes.

Chapter 4: Contextual Design Models and the Representation of Learning Activity. The five kinds of work models are the focus of this chapter. Each model is exemplified and analyzed to reveal what aspects of work are expressed in the model, and those expressions are critiqued from the perspective of studying the work of teaching and learning. The contributions of this chapter are to provide a formal analysis of the models and to investigate what adaptations may be required if the models are to be effective in describing the aspects of teaching and learning relevant to system design.

Chapter 5: Survey of and Interviews with Contextual Design Practitioners. The fifth chapter describes a survey of CD use by people who have learned about or used CD, with follow-up interviews of selected survey respondents. The research does not focus on ISD practitioners but rather examines CD use generally. The examination, however, is guided by the findings of the foregoing four chapters, which are used to develop a preliminary summary statement about the utility of CD. The focus of the survey and interviews is both behavioral and attitudinal: How do people who have learned about CD report using it? What parts to they use? What about it do they find valuable? How valuable? Why? The conclusion section offers a revised summary statement about CD practice. The contribution of this chapter is to provide the first broad account of CD in practice.

Chapter 6: Implications for the Design of Educational Technology. With an improved understanding of how CD is used and characterized by HCI practitioners, it is now possible to suggest what parts (e.g., principles, techniques) might be of benefit to ISD, and the ways in which they might be of benefit. The final chapter assesses the potential of CD for educational technology, and outlines future work needed to extend this line of research.

Benefits

Before embarking on this practitioner-oriented study, it is worth considering who is expected to benefit from these findings, and the nature of the anticipated benefits. The primary anticipated beneficiaries are developers of instructional “places” or interactive materials who find themselves at the intersection of instructional design and information system design. These designer-developers can expect help in thinking about how to characterize the design challenges they face and in adapting CD as a method, or some of its techniques, to better address those challenges.

A secondary group of anticipated beneficiaries are those educators of instructional designers who want to prepare their students to participate effectively with software developers in creating learning environments. HCI has worked at bridging the gap between designer and developer, and CD represents one of the better-defined bridging processes. Whether CD itself is used or not, studying it can provide the educator or the educator’s students with a better understanding of ways to bridge the gap.

A third group of possible beneficiaries are educational researchers who want to create online instructional places or interactive materials, and who are looking for a thoughtful approach that can be followed by relatively inexperienced graduate students. The step-by-step CD process offers scaffolding for an activity that can sometimes be arbitrary or chaotic.

A Note on Terminology

The terms *method*, *methodology*, *technique*, *process*, *step, framework*, *approach*,, and others are used inconsistently across (and sometimes within) the various writers and disciplines this study will visit. For example, in the initial CD book, Beyer and Holtzblatt (1998) referred to CD as both an approach (p. 3) and a process (p. 415); only the book’s forward by Marshall McClintock refers to CD as a methodology. Specific parts of CD are called methods or techniques (p. 5). In the second CD book, Holtzblatt et al. (2005) referred to CD as a collection of techniques (p. 22) or a method (p. 38) and use *methodology* to refer to a company’s predefined process for software development with which CD must fit (p. 24). When others write about CD, they might entirely reverse the terminology. Preece et al. (2002) labeled CD a technique and describe CI (one of the steps of CD) as an approach (p. 295).

For this present study, Löwgren and Stolterman's definitions offer some guidance: "a technique is smaller in scope and ambition than a method" and a method is a multi-step recipe making use of multiple techniques (2004, p. 63). Adapting this hierarchical model slightly, the present study uses *process* and *method* as synonyms, with reference to CD and to cognates, except in cases where constituent components are not sequential in nature. In this last case, *framework* is preferred. *Approaches* is used as the most general term. CD, participatory design, and PRInCiPleS are all examples of approaches.

The six constituent steps of CD remain *steps*, each of which consists of one or more *techniques*. Thus the redesign step consists of three techniques: walking the wall, storyboarding, and visioning. CI, as a step of only one technique, is referred to either as a step or a technique, depending on the point of comparison.

The relationship between *method* and *methodology* is particularly troublesome, but the latter term seems to connote a more self-conscious attention to comprehensive or definitive method, an organized system of methods, or the methods of another field that appear more formal to outsiders than to insiders. This term is avoided except in reference to its use by others.

The term *model* is used throughout to refer to the diagrammatic representations of work practice used in the second and third steps of CD.

2. CONTEXTUAL DESIGN AND INSTRUCTIONAL SYSTEMS DESIGN

This chapter, adapted from Notess (2004a), considers how the CD methodology can be applied to the development of educational software and how CD might interact with ISD. Beginning with a brief overview of ISD, the chapter then provides a case study of the application of CD to educational software development: to the design of an online tool for music listening and analysis in undergraduate and graduate music education. The case study shows CD in action and explores preliminarily the utility of CD in an educational context. The chapter concludes with some reflections on the relevance of CD to instructional systems designers.

Instructional Systems Design

The ADDIE (Analysis, Design, Development, Implementation, Evaluation) model of ISD provides a general framework for designing instruction. The model seems to have emerged anonymously during the 1960s (M. Molenda, personal communication, August 1, 2002) but has since become broadly known. In a 1988 booklet from the American Society for Training and Development, ADDIE is described as one of a variety of models for ISD (Grafinger, 1988, p. 2). A web-search of “addie” and “instructional systems” yields hundreds of hits. ADDIE is widely known and is sometimes even described as THE ISD model (e.g., Clark, 1995).

However, ADDIE is not the only model for ISD. Over the years, more comprehensive, flexible models have evolved. It is these more recent models that structure the textbooks in the field (e.g., Dick & Carey, 1996; Kemp et al., 1998). For example, the Kemp et al. model contains nine elements (their preferred term) instead of five (pp. 5–7).

1. Instructional problems
2. Learner characteristics
3. Task analysis
4. Instructional objectives
5. Content sequencing
6. Instructional strategies
7. Designing the message

8. Instructional delivery

9. Evaluation instruments

Kemp et al. (1998) provided some additional overarching topics such as project management, planning, and support services, thus making their model more comprehensive than the basic ADDIE model. Their model is also explicitly flexible, stating that not all steps need be used in every situation, nor do the steps need to be strictly linear (pp. 5–7). The authors emphasize the need for formative evaluation and revision during design (pp. 162–163).

In contrast to the CD process, ISD models are process models for the development of instruction or instructional *systems*. In this context, the term “systems” refers to the interrelatedness of all the parts of an instructional program and the attempt of the development process to account for the many parts and their interdependencies. ISD primarily targets instructional *content* (objectives, material, sequencing, testing). CD grew out of a very different background, in which “systems” means “information systems” as comprised by computers, software, and related technology. As a (computer) system design method, CD focuses on how best to design systems (hardware, software) to meet customers’ needs. While these needs may include learning or training, the concern is less with learning how to do something than with actually doing it—quickly, cheaply, and effectively. With instructional design, *content* is nearly always critical. With CD, as will be seen below, *work practice* is critical.

The Case Study

Variations2 was Indiana University’s NSF-funded Digital Music Library project (Indiana University, 2007). One of the main goals for the project was to integrate digital music content (audio, video, and scores) into undergraduate and graduate music education. Therefore, in addition to delivering a body of digitized content as a digital library system, the project also developed pedagogical software that faculty and students use for music teaching and learning. This case study describes how CD was applied to the development of this educational software. When this study was carried out, the first version of Variations2 had already been designed and was being developed. The researchers in this study, apart from myself, were not part of the Variations2 software team but were students in a graduate course in HCI. One benefit of this arrangement was that most of the researchers were unaware of design work that had already been done for Variations2, so the CD process was expected to provide new data to assist with future versions of Variations2, and to confirm or challenge our earlier design decisions.

This case study illustrates the CD process. It describes the activities undertaken and exhibits some of the resultant diagrams and data. It shows the initial CI, modeling and consolidation, the redesign and paper prototype interview phases. But it omits the user environment design phase, which was not undertaken because of the time constraints of the academic semester.

Contextual Inquiry

When designing something new, one cannot observe people using that new thing because it does not yet exist. Typically, however, the work that the new tool will support is work that is done today, but with different tools. In this case, music students were already going to the music library, listening to music, following along with a score in hand, and performing various kinds of analysis. Researchers therefore conducted CI into this current work practice.

Five researchers observed undergraduate music students who were completing listening or analysis assignments in the Cook Music Library on the Bloomington campus of Indiana University. Students were recruited via a signup sheet passed around during a music class, and received a $10 gift card for their participation. During the observations students were doing real work (class assignments, studying for a test, preparing for a recital) using the previous production system called Variations (Indiana University, 2002). Researchers took notes on what they observed, and at the end of the session asked the students questions to validate their interpretation of what they had seen.

Work Modeling

Researchers worked as a team in interpretation sessions to share and analyze the results of their individual inquiry sessions. As each interviewer talked through the observation, the other team members sketched CD work models on flipchart paper. Subsequently, some of the models were redrawn using a computer. The five kinds of work model are described and analyzed in further detail in chapter 4; here, examples are given to illustrate the case.

Flow Model

Figure 2 shows one of the individual flow models created after conducting CI with a music student preparing for a recital. U1 is the code name for the observed student.

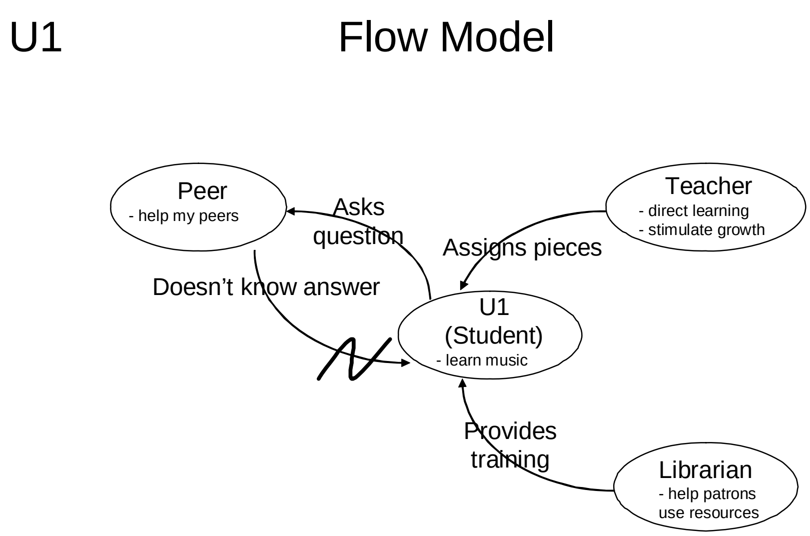


Figure 2. Flow model.

In the flow model, ovals represent roles and the responsibilities those roles demonstrate. The arcs between ovals show the communication or artifacts that flow between the roles. A dark, squiggly line (usually drawn in red) indicates a work breakdown. Work breakdowns represent occasions when the student had a difficulty. In this case the student attempted to get an answer to a question but was unable to.

This is a fairly simple flow model as studying tends to be a solitary activity. The student is listening to pieces of music assigned by her teacher in order to learn them. The activities performed by the teacher and the librarian were not actually observed during the inquiry session. However, in response to questions by the researcher, the student described the events. This asking about previous events Beyer and Holtzblatt called “retrospective accounting” (1998, p. 49). Retrospective accounts of real events are distinct from generalizations about behavior (e.g., “I usually do things this way”), which do not describe actual events and in CD are considered less reliable guides to understanding.

Sequence Model

Figure 3 shows the second page of a sequence model. The sequence model shows four work breakdowns (abbreviated BD on the left-hand side, shown by a dark squiggle on the right-hand side). The left-hand side of the sequence model captures the researcher’s meta-level notes about what is happening and why, along with breakdowns. The first breakdown in this example has a question mark after it because the researcher is not sure whether it can truly be considered a breakdown. The student is not able to find the precise location desired in the recording, but the student does not consider this to be a serious problem. *Intents* are the objective the student was trying to accomplish. In this example, the student decided to find out who the second performer is and where he or she received training. The right-hand side captures the user’s actions and the system’s response. The indented text indicates parallelized activities. Thus, while one recording is loading, which took several minutes, the student browsed through other recordings in the online library catalog system (IUCAT).

U1 Sequence Model p. 2

	Adjusts volume up by hand during quiet part Adjusts Master Volume up by hand Moves slider back a bit to listen to section again
BD?: Overshoots by 40 seconds--but says it's okay--not in a hurry	Looks for second recital piece ("schubert and piano and sonatas and http") Finds only one in Variations--teacher said this isn't a good one Loads it While loading, looks at some other recordings
BD: hard to scan for piece	Scans "Contents" field to see if it includes the right piece Finds another one Also loads it
Intent: find out who second performer is--where received training	Starts listening to first one Goes to library database search page Types in performer's name
BD: misunderstand database search; doesn't remember how to use it; librarian showed her once	Decides 1st recording is too slow Switches to second recording Goes to google Types in "bilson and malcolm and biograph" (BD: Typo) Notices error (? No results?) Goes back, adds "y" to "biography"

Figure 3. Sequence model.

Cultural Model

The cultural model (Figure 4) shows the person being observed at the center of the surrounding cultural influences. Arrows represent pressures (e.g., a teacher telling the student to play a piece in a particular way) and "push back" (e.g., the student insisting on following her own interpretive instincts). Most of the cultural model data were gathered through clarifying discussion with the student about why she was doing certain things (retrospective accounting). She reported conversations with her teacher and explained why she was looking for a variety of recordings. She also expressed frustration at how little she knew about how to use the technology. She reported that the library had provided training but that she could not remember what she had learned.

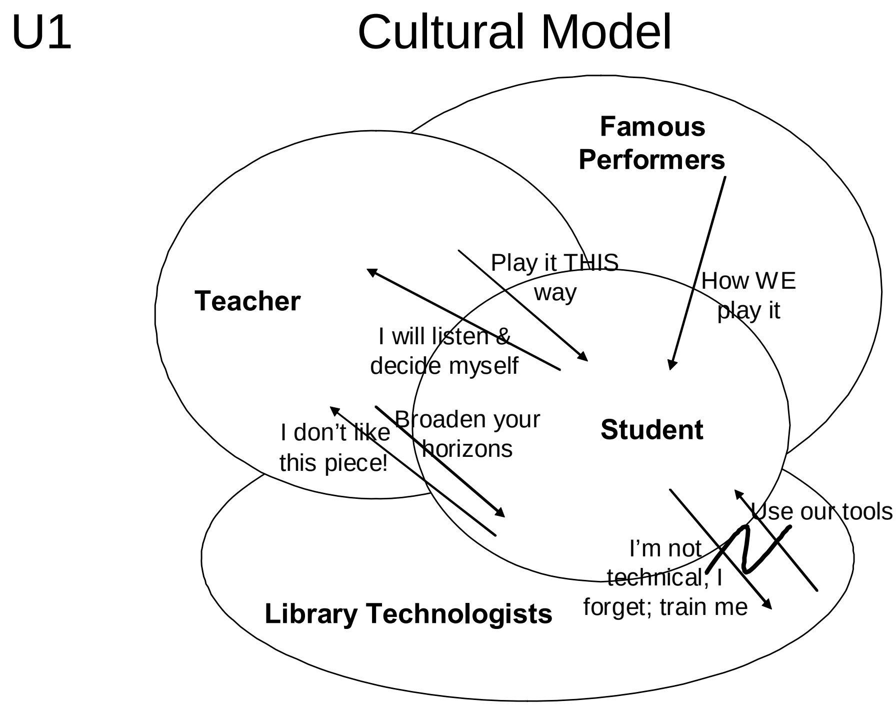


Figure 4. Cultural model.

<u>Physical Model</u>

In this study, two aspects of the physical work environment were captured in models. The first is the workspace, complete with computer monitor, music keyboard, typing keyboard, mouse, and headphone jacks (see Figure 4). The second is the computer display, showing the observed layout of the online catalog and the audio player (Figure 5). The models are annotated to call attention to certain features and observed behavior, even as trivial as noting that the student drummed her fingers on the edge of the desk. While not all of these details (or indeed details from the other models) may be useful in subsequent design, they can help make the observed user experience more memorable for the researchers.

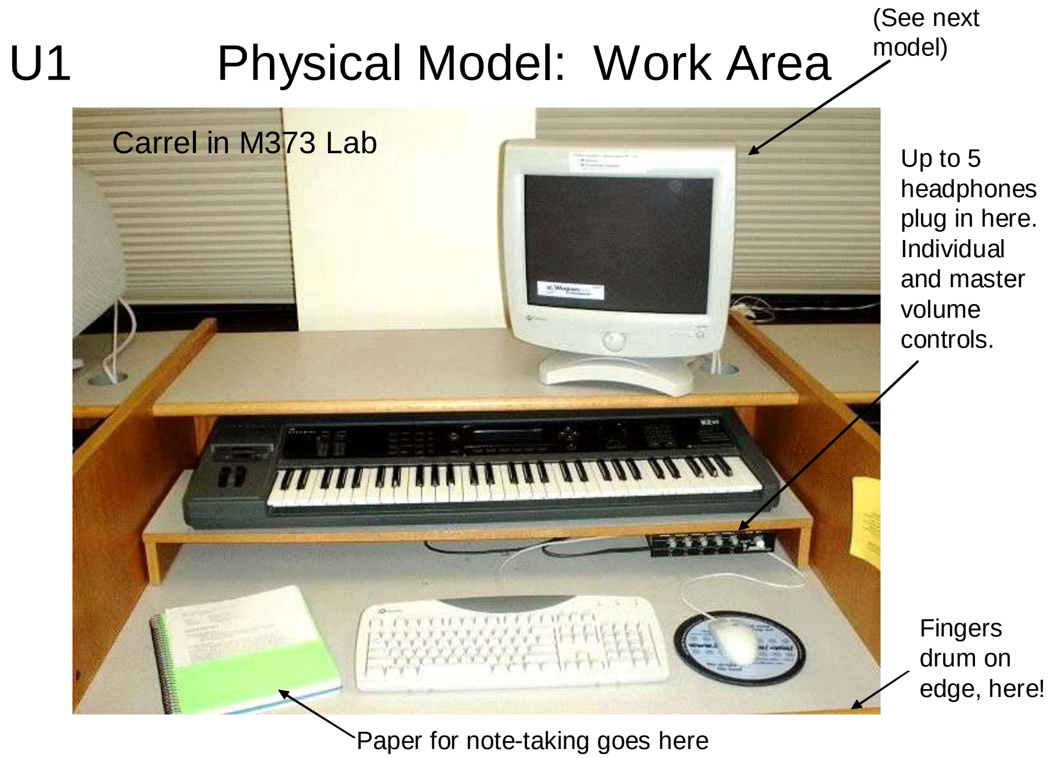


Figure 5. Physical model of the workspace.

The second physical model (Figure 6) shows two breakdowns: the difficulty of scanning the online library catalog record for useful information, and the difficulty of controlling the audio playback offset precisely. For both of these physical models, the initial renditions were sketched by hand, but subsequently, photographs and screenshots were used to provide richer detail.

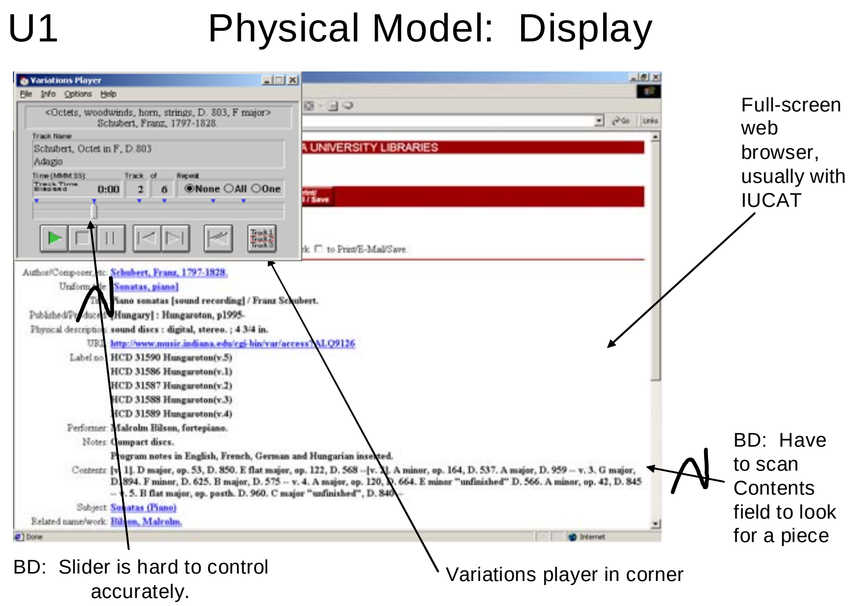


Figure 6. Physical model of the computer display.

Artifact Model

The artifact model (Figure 7) shows a diagram of the work artifact, annotated with explanations. The artifact was a half-sheet of paper upon which the student wrote notes to herself while listening. When subsequently asked about the purpose of the notes, the student said that these are a reminder to herself.

Insights

At the end of each interpretation and modeling session, researchers created a list of insights about what had been learned about the work. Insights from the U1 interpretation session are shown in Figure 8. The "DI" abbreviation after the last insight in the list was a "design idea" offered by one of the researchers. Design ideas are flagged so as not to confuse them with user data and to facilitate going back and looking at design ideas in preparation for redesign. Not all insights may be profound. However, the seeds of nearly all subsequent work redesigns were represented in one or more of the insight lists.

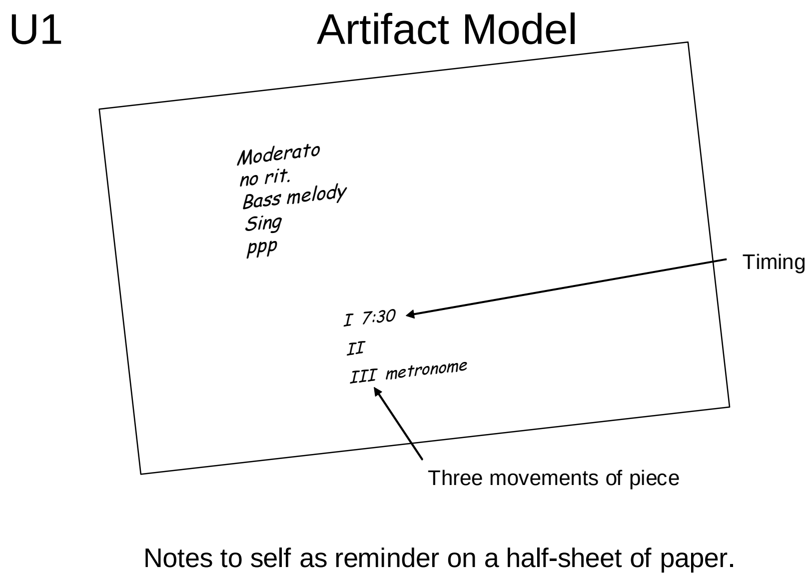


Figure 7. Artifact model.

U1 Insights

- Lack of Mac support w/Variations is a problem
- "High-level" listening tasks are different from detailed listening
- High-level listening can be multi-tasking
- Finding resources on the Web is easier/more familiar than using library resources
- Need user education
- Didn't use any non-visible features (hidden behind button or menu)
- Need a way to see all performances of the same <u>piece</u>. DI: do this in Variations.

Figure 8. Interpretation session insights.

Work Notes

During the interpretation session, a running list was kept of any data that were mentioned but did not fit into one of the other work models. Table 2 shows the work notes from the U1 interpretation session. Again, “DI” refers to design ideas from the researchers. “Q” indicates an unanswered question researchers had, which they could later look into if it ended up being an important question.

Consolidation

After all of the interpretation sessions were complete and all the individual models were built, researchers consolidated the models. Table 3 shows one of the consolidated models, the consolidated sequence model. Reading down the left-hand column yields a sense of the main kinds of work in which Variations use was involved. The center column lists the users’ intents for each of the activities. The right-hand column shows alternative steps users took to accomplish their intents, at a higher level of abstraction than the individual models. The abstract steps show multiple methods of accomplishing the same intent using “Or.” Thus, in preparing to do an assignment or study for a test, students either looked at a paper syllabus or at their course website online to determine what to do.

In addition to consolidating work models, researchers also consolidated the work notes, using the affinity diagram process. In all, the five interpretation sessions generated 99 work notes. Researchers organized these notes hierarchically by topic. Table 4 shows data from one of the five major sections of the resultant affinity diagram. Work breakdowns (BD) and design ideas (DI) are also incorporated into the affinity.

Table 2
Work Notes

U1	1	Profile: performance student prep. for recital; pieces memorized; listening to interpretations to compare to teacher's.
U1	2	Realizes (too late) that Variations doesn't work on a Mac.
U1	3	Moves to another computer with a different monitor, but it is also a Mac.
U1	4	In Var., moved back 40s too far using slider bar.
U1	5	She does not use a score b/c it distracts her; pieces already memorized.
U1	6	Her teacher is very opinionated but compromise on interpretations is possible.
U1	7	Teacher comments have influence on her choice of recital pieces.
U1	8	Hard to scan "contents" field for a piece on a CD.
U1	9	Asks interviewer how to search a library database.
U1	10	No results for search for performer name in library DB.
U1	11	Misspelling error in Google search query: "biograph" instead of "biography."
U1	12	Goes to "bad" results page; not clear which results pages are best.
U1	13	Wanted the bio. info. purely for her own knowledge.
U1	14	Domain "experts"/larger community standards influence her perception of appropriate performance time, interpretation, etc.
U1	15	Listens to music on CDNow/Borders instead of using available library recordings; Possible professor influence.
U1	16	Q: Is she going to go back and do detailed listening? Is high level all she needs?
U1	17	Frequent IE browser error messages; public access computers have to be "retrained" for profiles.
U1	18	Q: Why didn't she use Var. track buttons or Options menu?
U1	19	Has never been instructed on how to use Var.; would like a "Clippie" feature to assist her.
U1	20	DI: Include a link to info. about the performer.

DI = design idea

Work Redesign

Based on what had been learned about users of Variations, researchers brainstormed ideas for making improvements that would better support people's work, creating rough vision sketches on flipchart paper. Researchers decided to focus on addressing three recurrent issues: figuring out how to use the system, finding the desired media, and doing detailed listening. This work produced three designs that were worked out in greater detail, titled "Live Help," Search for Music," and "Set Loop/Navigate by Measure."

Live Help: To help users more easily figure out how to use the system, researchers decided to take advantage of current instant messaging technology to design a means for users to ask for help from a librarian right when the help is needed. This way, instead of having to flounder or ask students working nearby, users could instead get immediate expert advice from reference-desk personnel.

Search for Music: A second observed difficulty was searching for a listening piece. IUCAT did not make this easy. Students could do keyword searches for the name of the composer or the piece but then had to sift through many bibliographic records, visually scanning for the name of the piece or composer amid many other fields of data. The improvement idea here was to allow for more specific searches such as composer, performer, and/or genre, in effect introducing music-specific concepts into the search and retrieval process.

Table 3
Consolidated Sequence Model

Activity	Intent	Abstract Step
Figure out What to Do	• Focus Activity • Prepare for correct assignment or test	• Read paper syllabus copy Or • Go to course website
Gather/Locate resources	• Find the piece needed for assignment • Locate multiple versions of pieces to prepare for performance	• Go to course syllabus site Or • Go to IUCAT o Course Reserve lists -Or- o Search Or • Go to CDNow.com or other commercial site 1. Search 2. Listen to clips • Determine if appropriate music has been found
Listen (Overview)	1. Get a sense for the piece 2. Determine appropriateness of the piece for intended need.	1. Click play on Variations 2. Listen 3. Make notations on paper score
Listen (Detailed/Analytical)	1. Analyze chord changes 2. Find Transitions in the music 3. Prepare for transcription	1. Click Play on Variations player 2. Listen 3. Stop 4. Restart from beginning -or- pause 1. Move slider back to try to find beginning of section 2. Click play • Make notations on score • Repeat

Table 4

Affinity Section for "I figure out or find what to work on"

I figure out or find what to work on

- How I figure out the assignment
  - Reads description in syllabus + underlines 2 sentences to "keep straight what I should be listening for…"
  - Looks in day planner for assignment notes. Planner is a detailed artifact with many course notes.
  - She says that she still hasn't obtained a binder for her paper scores and class notes. "I really need" one, she says.
  - Found piece in Variations from class syllabus [explained this after interview started].
  - Checked e-mail using Webmail interface for message and link to class webpage from instructor
  - Working section F. of syllabus
  - BD: "Transcription looks wrong compared to example and what I am hearing…"
- How I find what I need to listen to
  - Listens to music on CDNow/Borders instead of using available library recordings; Possible professor influence.
  - BD: Hard to scan "contents" field for a piece on a CD.
  - Always tries to use listening list in course reserve page to find correct version.
  - Retrospective: got to Variations from class listening list
  - BD: Locating correct version of piece difficult in IUCAT
  - BD: Initially played the wrong piece in the Variations player. Says "it doesn't seem right."
- How I find what I need to look at
  - BD: Hard to specify score or recording in IUCAT, search criteria are for books not music
  - DI: Would like to be able to find paper score along with recording in same search.
- I need to find more information
  - Goes to "bad" results page; not clear which results pages are best.
  - Wanted the bio. info. purely for her own knowledge.
  - DI: Include a link to info. about the performer.

BD = breakdown; DI design ideas

Set Loop/Navigate by Measure: The Variations tool provides a slider control and typical media control buttons (previous/next track, fast forward/rewind, pause, stop and play). Nevertheless assignments often required students to answer questions about specific segments of a musical work such as, "Discuss several ways in which Beethoven creates disruption, or discontinuity, in the music between measures 37–59." To locate the exact measures in the audio, students referred to a paper-based score and typically adjusted the slider trying to find the right location so they could answer the question. Often, students wanted to listen to the same segment repeatedly in order to complete their analysis. Yet the only precise locations in the audio by which students could navigate were the beginnings of each track. So they resorted to using the slider to try to find the right location. The work redesign provided two ideas: allow students to navigate by measure number and to set specific repeat loops.

Storyboards showing improved methods for each of these tasks were created. The storyboards were summarized in a redesign diagram that became the basis for subsequent paper prototypes. Figure 9 shows one part of the redesign sketch, indicating the ability to navigate by measure number.

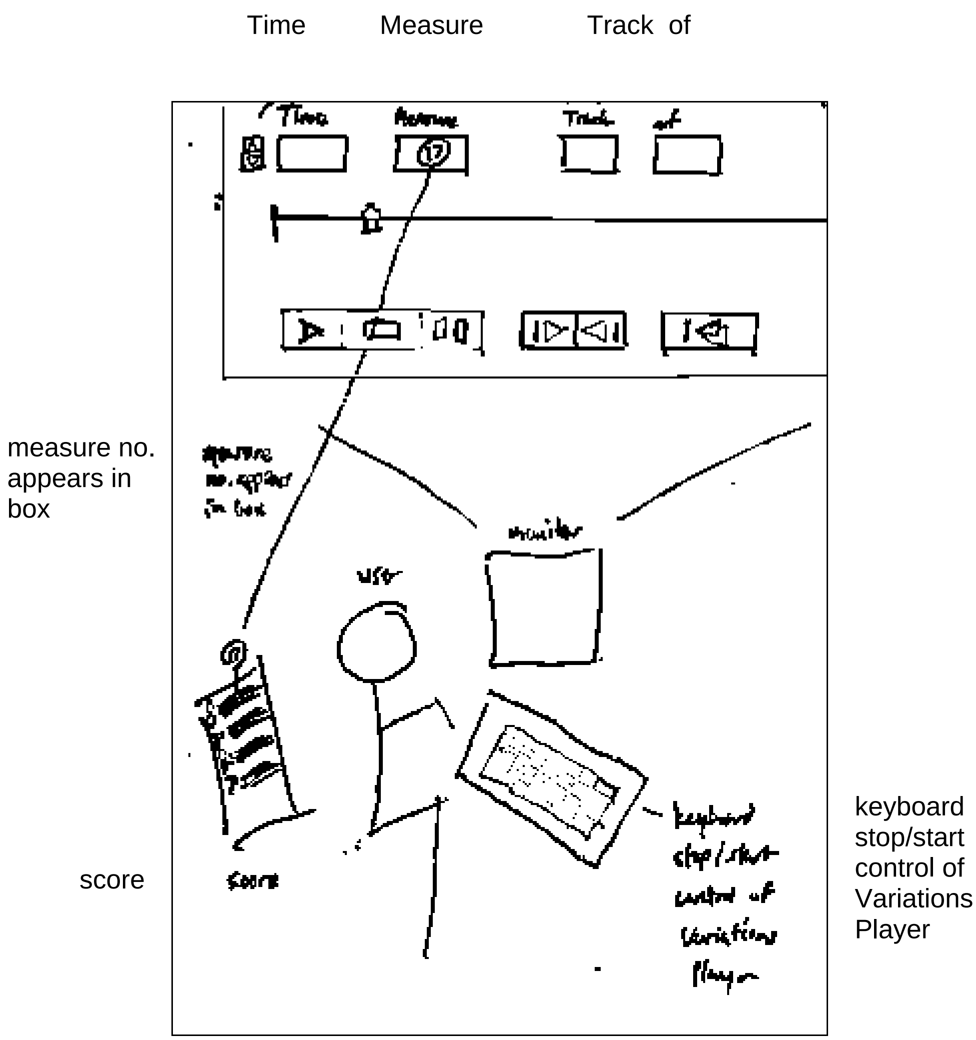


Figure 9. Part of the redesign diagram (annotated for legibility).

Given that these redesign ideas emerged from acquaintance with the data in isolation from the development team, it was interesting to note the extent to which the redesign correlated with the Variations2 design work. Of these three redesign ideas, the first one (Live Help) was wholly absent from the Variations2 plans. This is not surprising, because CD, with its comprehensive look at what people are doing to accomplish their work, could be expected to uncover systemic problems beyond the feature set of a particular piece of software. The second redesign idea (Search for Music) is squarely in the center of one of the main emphases of Variations2, so the CD work confirmed the need for cataloging schemes that work well for music. The third redesign idea (Set Loop), had mostly emerged in Variations2, which provides measure-by-measure navigation and offers a bookmarking mechanism somewhat analogous to the "set loop functionality. Version 1 of Variations2 provides a way for users to add a bookmark at any point in a recording or score. These bookmarks can then be brought up in a separate window and used for navigation. The CD research results yielded a mechanism more tuned to the observed student tasks: listening repeatedly to a segment with a defined beginning and end.

Paper Prototyping

Paper-based prototypes based on the redesigns were created, taken back to the music library, and put in front of music students who were asked to attempt to "use" the prototype to do a task they needed to do or had recently done. Figure 10 shows one of the paper prototypes. As can be seen, the prototypes are quick and easy to construct and invite correction or improvement.

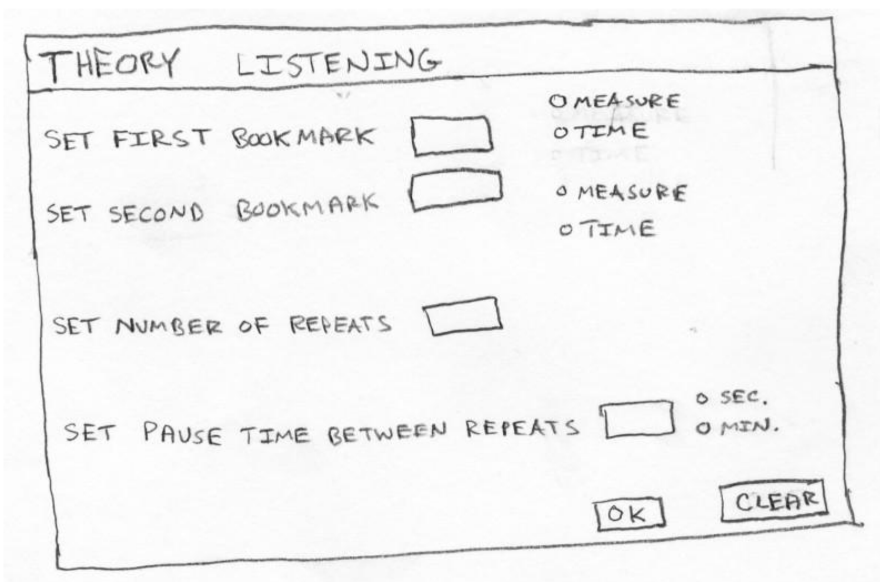


Figure 10. Sketch for a paper prototype.

Paper prototyping interviews gathered feedback on three levels: the user interface, the underlying system structure, or the researchers' understanding of the user's work practice. The 31 issues gathered from paper prototyping interviews were therefore categorized accordingly. Table 5 shows a few examples from each of these three categories.

User interface problems tend to be the easiest to fix. In the Table 5 examples, relabeling will solve any of these issues. Issues with system structure run a little deeper and have a large impact on design. For example, providing “in-depth information about a musical piece from within Variations” would require additional user interface elements and would likely require significant changes to the underlying implementation to provide this additional data in (or from) the listening window. Work-practice issues have the potential to transform a design completely. In the Table 5 examples, the first two work practice issues have fairly minor impact, but the last issue rules out the entire mechanism used by the paper prototype to set markers: a separate dialog box with data-entry requirements is too disruptive; students need a simple way to set a mark while listening. So the impact of this work-practice issue ripples through the system design and the user-interface design.

Table 5
Sample Categorized Feedback from Paper Prototype Interviews

Category	Issue
User Interface	“Ask the Librarian” should include the word “live” or some other note to let users know that the function is live help.
User Interface	Better name for theory listening may be bookmark repeat or loop listening.
User Interface	Likes “Set Loop” and recognizes this terminology to set marks in music; didn’t care for the term “bookmark.” She suggested “begin loop” and “end loop.”
System Structure	Students want the ability to get in-depth information about a musical piece from within Variations.
System Structure	Leave theory listening window open while repeating.
Work Practice	Many students may not know in advance how many times they want a section repeated, so maybe just keep repeating until the user stops.
Work Practice	Grads want to compare recordings often—this subject would like to see unique information in the title window to distinguish between different recordings.
Work Practice	There is a whole type of listening we missed in the first round of interviews. This is listening for some sort of theme that needs to be supported by a marker that won’t stop the piece, but allows the student to go back easily and hear again.

The paper prototypes were rapidly developed and tested, and after only four interviews, a wealth of user data both validated and invalidated aspects of the user interface design, system structure, or understanding of the work practice.

The Ongoing Value of the Data

Although the CD activity was only a small and somewhat disconnected effort in the scope of the overall Variations2 project, results from the study continued to influence the requirements and design for future versions. For example, in response to the loop concept, the Variations2 team included, in version 2, the ability to define an excerpt, a segment with a beginning and end (not just a beginning as with the bookmark concept). In addition, having learned about the difficulty students have finding the right listening piece, the Variations2 developers prototyped a visual syllabus that would allow students to go to an online syllabus with a link directly to the pieces or segments for each assignment (Notess & Minibayeva, 2002).

Conclusion

This case study is exploratory, small-scale, and was not a formal part of the development project, so any attempt to declare success and recommend adoption of CD would be uncompelling. The intention of the exploration was to examine the possible fit between CD and ISD. This section offers two observations about this fit. First, CD may be both susceptible and resistant to two recent criticisms of ISD. Second, CD may offer some needed process commonality between the design of instruction and the design of the technology used in instructional delivery, which at least merits further exploration.

Contextual Design and Criticisms of ISD

Recently, ISD has been the target of significant criticism (Gordon & Zemke, 2000). Among the criticisms are the assertions that ISD is both slow and cumbersome and that it focuses designers on following a process rather than on achieving meaningful results.

Over the years, I have heard these same criticisms leveled at CD by casual observers of the process. Seeing the work that goes into CD and the bewildering (to outsiders) array of flip-chart paper and sticky notes it generates, some people assume that

CD is a long, slow process. In my experience, the slowest part of the process is not the data gathering, analysis, redesign, or prototyping: these can move very quickly. In the present case study, the first three phases of CD (interviewing, interpreting, and consolidating) were all completed in 2 weeks' time by people who were working at other jobs and/or enrolled in other classes. The redesign, prototyping, prototype interviews, and the consolidation of the results took even less total time although they were spread over a month of calendar time because of a vacation break and delays in recruiting students for the prototype interviews. It is this latter problem—recruiting interviewees and scheduling the interviews—that can stretch out CD schedules. Beyer and Holtzblatt (1990) and Holtzblatt et al. (2005) offered guidance on how to make CD fast and effective for a variety of situations.

The second criticism of ISD mentioned above is that it can focus people on following a process instead of achieving results. This is always a risk when there is a detailed process to learn. However, CD may be less susceptible to this weakness than other processes because of its insistence on putting all members of the design team face-to-face with real users. Most users are less concerned with what process designers use than they are with the resulting product. Having the images of those users imprinted on designers' minds and their work breakdowns pointed out in red on the work models, designers are less likely to disregard users' needs in favor of following a process for its own sake.

In a follow-up article, Zemke and Rossett (2002) summarized some of the responses received to the original Gordon and Zemke article that criticized the ISD process. They divided the responses into two groups. The first group blamed ISD itself as a faulty process and the second group blamed practitioners of ISD for faulty practice. Zemke and Rossett concluded that, though ISD may be flawed, it is (quoting M.Rosenberg) "the best thing we have if we use it correctly" (p. 34). In both the original article and the follow-up article, there is repeated emphasis on the expertise of the practitioner having a large impact on the quality of the results. There is no reason to expect that CD would not have a similar dependency. In all of the CD projects I have seen that could be termed successful, there was strong leadership from one or more skilled practitioner who had developed those skills under the watchful eye of an expert.

These skilled practitioners or their mentors could adapt and streamline the process to become effective in a given situation. The present case study relied on my expertise to guide the inexperienced students. What allowed the process to be useful is likely the expert guidance of a practitioner who can adopt the “thoughtful design stance” advocated by Löwgren and Stolterman (2004, p. 15), a stance that allows the process to be usefully adapted to a given situation.

Technology Design and Instructional Design

In the present case study, CD is used to guide the design of a software system deployed in an educational context, and indeed it seems potentially as useful here as it has been in other systems design problems. It also seems apparent, even though the present case study did not examine this, that CD might provide a useful approach for integrating technology design and instructional design. The need for this integration is experienced whenever an instructional designer and a software developer try to work together on a project or whenever the instructional designer tries to fill the role of both technology designer and instructional designer. The present case study involved only the development of software for music listening and analysis but did not include the development of instructional *content* such as a set of lessons to teach music theory. Had it done so, the interaction between CD and ISD might have looked something like what is represented in Table 6. Table 6 illustrates, by partial example, both the dichotomy and unity of interests between an instructional designer and a software designer during just the analysis and design phases of such a project.

As shown in Table 6, instructional designers have their unique expertise in areas such as learning theory, evaluation, and message design. Software designers also have their unique expertise in such areas as programming, software architecture, and the characteristics of different technologies. But both types of designers have a common interest in understanding the intended users and uses of the system, and both have a large stake in the design of the user interface. CD might help address the common information and design needs in such a cross-functional team.

Related and Further Research

Others are recommending or exploring the application of CD methods to educational problems. Nichani pointed to CD as one of several approaches that exemplify what he called “empathic instructional design” (Nichani, 2002). Druin, in her work designing technologies for and with children, has developed a design approach called “Cooperative Inquiry” which leverages in particular the CI piece of CD. Druin has applied this approach in designing a digital library for young children (Druin, 1999, 2002; Druin et al., 1998).

One area of need is to investigate the extent to which CD is valuable for instructional-content design. CI and work modeling may have applicability to the job/task analysis pieces of instructional-needs analysis. An unanswered question is whether subsequent steps of designing content such as sequencing and the selection of instructional strategies are helped, or at least not hindered, by CD. A particular area for inquiry is work modeling. Work models developed primarily for describing office work may or may not usefully describe the work of teaching and learning. Chapter 4 of this dissertation discusses this issue analytically.

Table 6
Dichotomy and Unity of Interests Between Instructional and Software Design

<table>
<tr><th></th><th>Instructional Designer</th><th>Software Designer</th></tr>
<tr><td>Analysis</td><td>What music theory content do the students need to learn?
What are the characteristics of the music students?
In what contexts will they be learning (classroom, library, dorm room, computer lab)?</td><td>What kinds and amounts of data will be needed (audio, image, video, text)?
What kinds of user interaction with the data are needed?
What technical constraints do we face (network bandwidth, display resolution)?</td></tr>
<tr><td></td><td colspan="2">Who will be using the system (how many users, how often, etc.)?
What tasks does the system need to support?
What other people besides students will need to interact with the system (e.g., faculty? librarians? administrative staff? graduate assistants?)</td></tr>
<tr><td>Design</td><td>What are the instructional objectives or outcomes we are trying to achieve?
How should the content be sequenced?
What instructional strategies best fit the goals and content?</td><td>What technologies (e.g., database, user interface, programming languages, software packages, networking, security) should we use?
What software architecture best meets the requirements?</td></tr>
<tr><td></td><td colspan="2">What should the user interface look like?
How can we best support collaboration and communication among users?</td></tr>
</table>

Despite the potential applicability of CD to instructional design problems, any real promise needs to examined more critically, particularly with respect to the primary goal of this dissertation. If, for example, people outside of education have not found CD to be enduringly useful in their own design practice, it seems less likely that CD would ever be used extensively on educational technology projects.

3. INTEGRATING HUMAN-CENTERED DESIGN METHODS FROM DIFFERENT DISCIPLINES:

CONTEXTUAL DESIGN AND PRINCIPLES

This chapter, adapted from Notess and Blevis (2004), contributes to knowledge about CD by comparing it to a recent encapsulation of a method from design as it owes to traditions of product design, communications, art, and architecture—PRInCiPleS (Blevis, 2004). Beginning with a description of PRInCiPleS, this chapter illustrates the design method by means of a case study that includes techniques drawn from CD but subordinated to the PRInCiPleS approach. CD and PRInCiPleS are then compared and their compatibility is assessed. The chapter concludes by reflecting on areas where PRInCiPleS could offer possible improvements to CD.

PRInCiPleS

At the School of Informatics at Indiana University, a design method was developed called PRInCiPleS. PRInCiPleS is an acronym for *Predispositions, Research, Insights, Concepts, Prototypes*, and *Strategies.* The PRInCiPleS steps are analogous to steps of an idealized scientific process—*initial hypotheses, prior art*, *research hypotheses*, *experiment design*, *experiments*, and *peer review*; these are simply analogies, not equivalences. PRInCiPleS is inspired by the tradition of design methods as interpreted by Eli Blevis, a former faculty member at the Institute of Design in Chicago. PRInCiPleS is not as well known in the design world as CD is in the HCI world. In fact, PRInCiPleS is just a local version or account of a representative design approach in the sense of design approaches that owe to traditions of art, architecture, and product design, but it serves here as a proxy for those design approaches.

PRInCiPleS is grounded in the notion that what the activity of design *is* matters less than what designs actually *are* (Blevis, 2004). PRInCiPleS is a framework for representing designs as arguments—plans or ex*plan*ations. Design is less a process and more an argument. Therefore, the PRInCiPleS components are elements of an argument rather than steps in a design process. Previous to even the first component is the assumption that there exists a target population of interest to the designer and a focus on some facet of that group's needs or desires. Following this initial assumption, the elements of the PRInCiPleS argument are as follows.

1. *Predispositions*—enumeration of all significant points of view about the population being designed for

2. *Research*—data from observations of the target population and/or collected instances of the culture being studied and/or literature review

3. *Insights*—interpretations of the research data that express essential opportunities for improvement of the environment of the target population relevant to the designer's focus and values

4. *Concepts*—an enumeration of design ideas germane to insights gained from research, organized into *systems of concepts* that work together coherently to create an improvement in the human condition of the target group

5. *Prototypes*—high (working) and low fidelity (behavioral or exploratory) and physical (appearance) expressions of selected design concepts, useful for concept exploration and refinement

6. *Strategies*—a proposal for moving forward, not neglecting business, technical, or social and ethical issues

PRInCiPleS has been applied primarily in the context of the Indiana University School of Informatics HCI program. Published accounts of design projects based on PRInCiPleS are available addressing a variety of design problems, such as collocated collaborative work (Wang & Blevis, 2004).

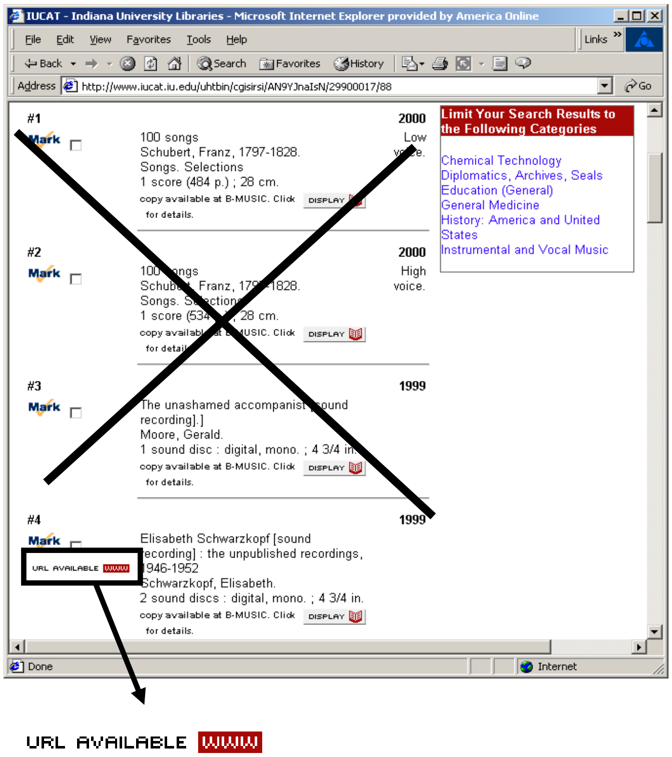
Case Study

The case study integrated some CD techniques into PRInCiPleS in an exploration of the information and library-related needs of graduate voice students at Indiana University. Following the CD approach, 14 CI-based observations examined four voice students engaged in graduate music study. Students were recruited from a graduate vocal literature class and received a $25 gift card for their participation in 2–4 sessions of 1–2 hours each. The observations focused on students' information needs, particularly as those needs pertained to the music library. Although most of the observations occurred in the music library, other activities such as a voice lesson (taking), a secondary voice lesson (teaching), an ensemble rehearsal, and a vocal literature class were also observed. Data gathered during the observational sessions were modeled using the CD models and then consolidated across observations. At that point, the PRInCiPleS approach was used to generate concepts, select prototypes, and construct a cohesive design argument.

The inquiry, modeling, and consolidation steps of CD were used as techniques for accomplishing the research and insights parts of PRInCiPleS. Work models from this same case study are shown extensively in chapter 4 of this dissertation and so will not be duplicated here. Regardless, neither the individual nor consolidated models participate in the *representation* of the PRInCiPleS design argument, which consists instead of terse statements illustrated by pictures or diagrams, at least in this case study. Other representations are possible and are not dictated by the approach, but rather by the audience for whom the design argument is prepared. In addition to the CI data, other sources informed the research, such as related articles. Figure 11 shows how a particular result of a PRInCiPleS research finding is presented as part of a design argument, incorporating elements from observational research as well as from a literature review. The research result is that users tend toward materials available online, sometimes exclusively.

A high-level diagram of the design argument obtained at the end of the process is shown in Figure 12. This diagram is not the public form of the design argument, but it serves here to show the structure of the resulting design argument. The final step, *Strategy*, is omitted from the figure, but the implementation strategy outlined two specific actions that could be taken as a result of feedback on the three prototypes. However, this case study did not include gathering prototype feedback or implementing the system. The bolded boxes are the ones shown in figures in this chapter.

Research: Easy Access



- If it’s not online, it isn’t there. (screenshot from www.iucat.iu.edu)
- For most assignments, students limit themselves to online resources.
- “Media and ease of access will continue to be key factors in how scholars choose materials.”

Figure 11. A PRInCiPleS research finding presentation.
From *Scholarly Work in the Humanities and the Evolving Information Environment* by W. Brockman, L. Neumann, C. Palmer, & T. Tidline, 2001, Washington, DC: Digital Library Federation, p. 17.

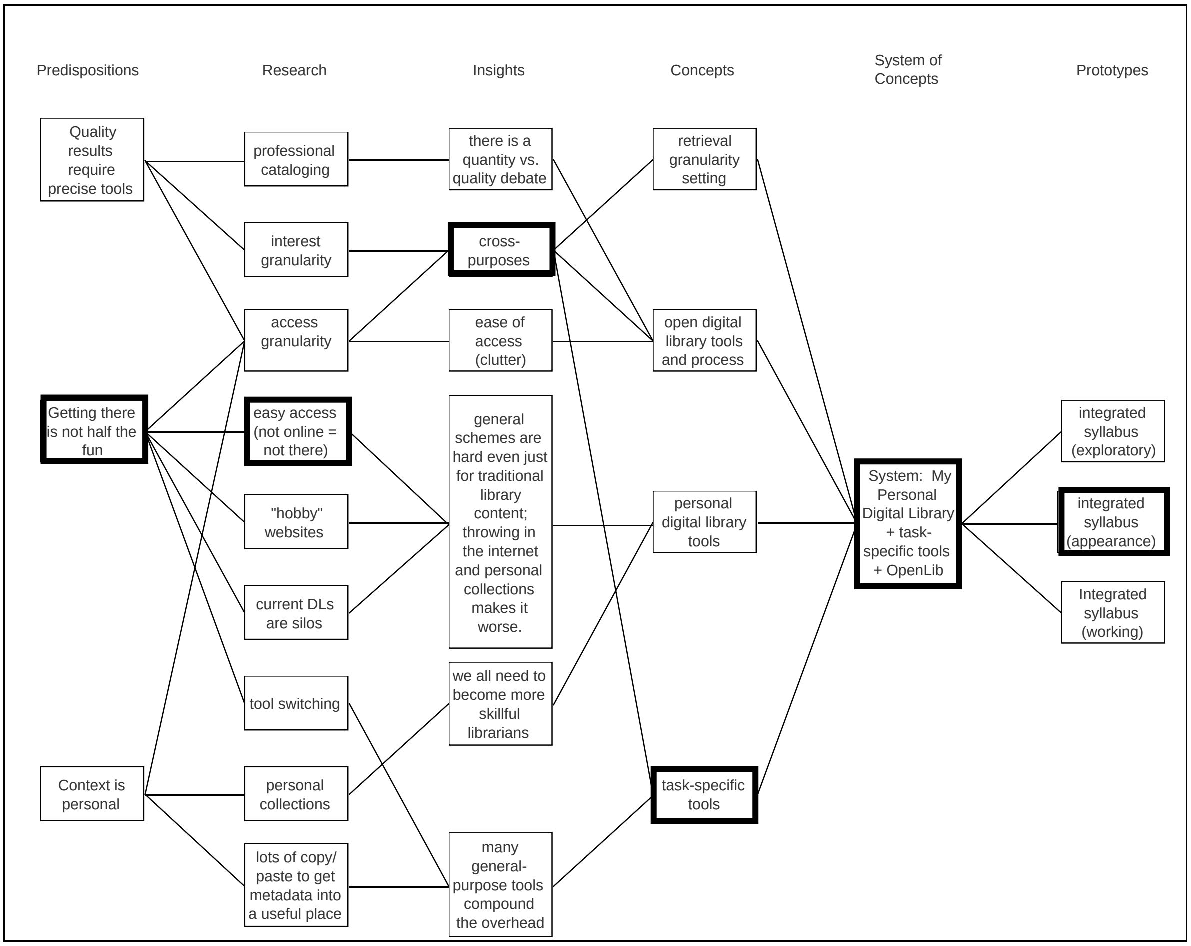


Figure 12. PRInCiPleS-based design argument summary: Design intervention plan for the digital music library.

Although the design argument is itself sequential, moving from left to right in Figure 12, the process involved in creating the argument is not necessarily a linear one. Subsequent to the CI, modeling, consolidation, and the statement of the research findings, predispositions and insights were developed. Predispositions are overarching statements of perspective framing the entire design argument. Their representation and presentation is conceptual and symbolic. Figure 13 shows the presentation of one concept, “Getting there is not half the fun.”

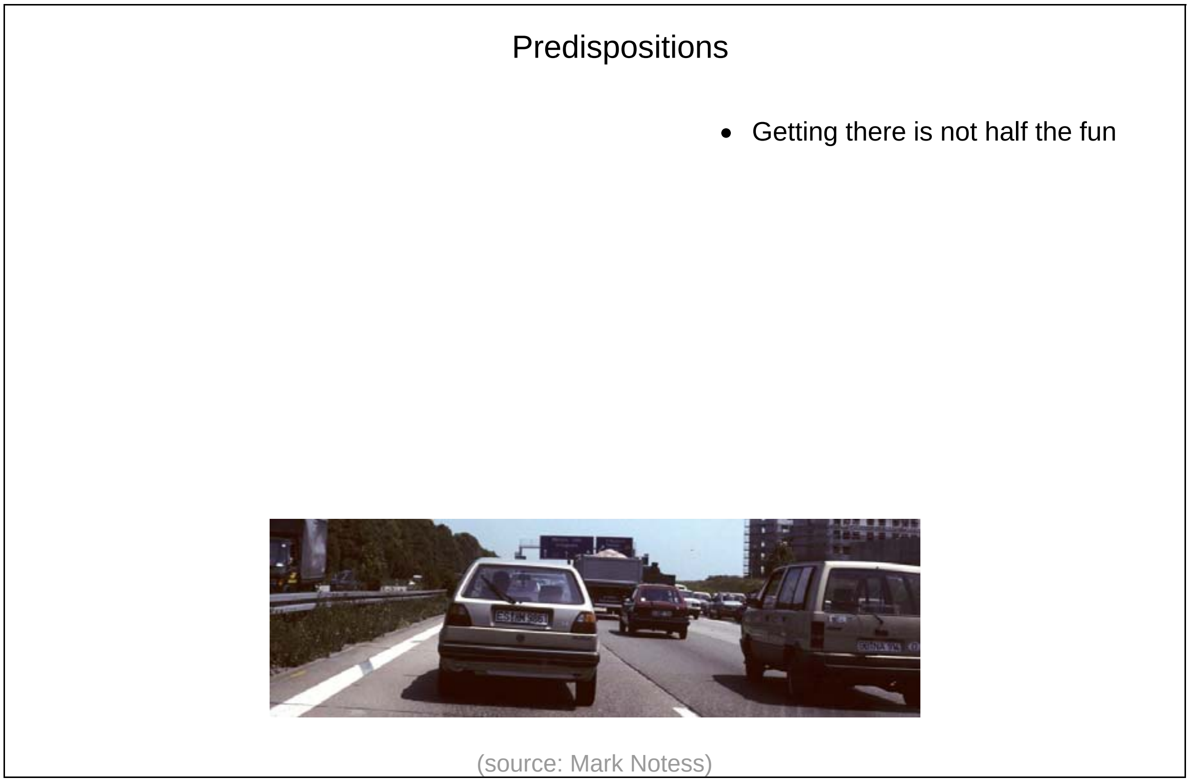


Figure 13. Sample predisposition presentation.

The insights express the essential opportunities for improvement in the culture being studied. Figure 14 shows an insight gleaned across multiple tasks from multiple observations: the level of granularity of library collections and access points often does not match the access needs of users. Whereas libraries collect published wholes, such as books or albums, students often need direct access to a part of the whole, such as a single song, or a section of a book.

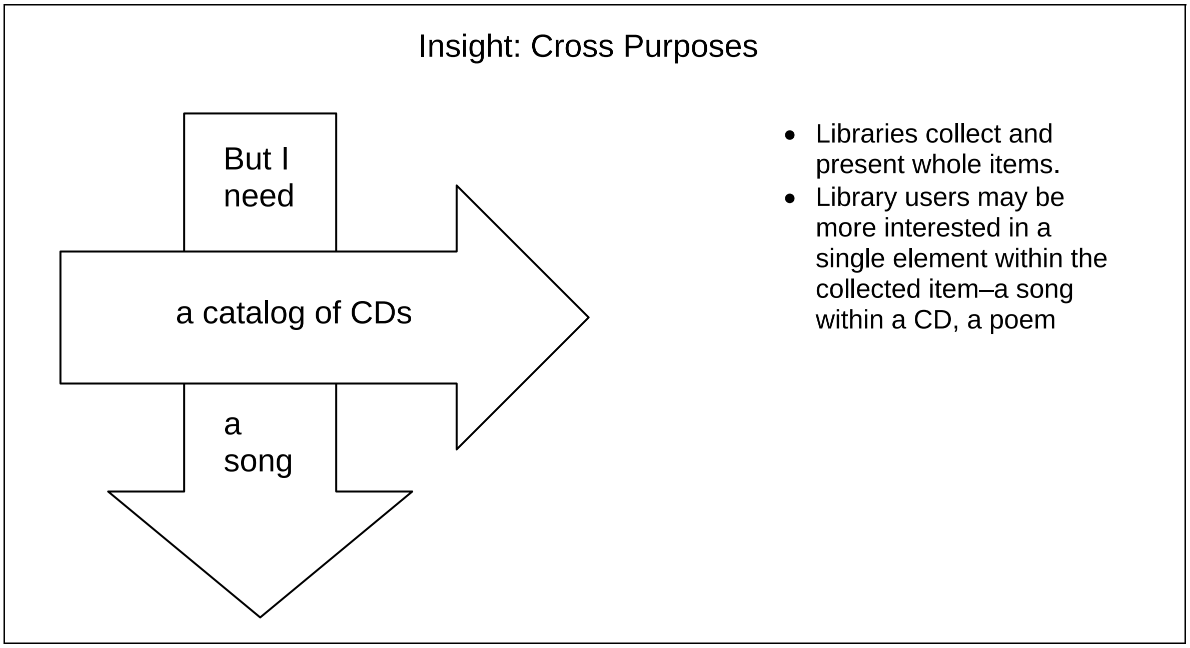


Figure 14. Sample insight presentation.

From the insights, the creative leap is made to design ideas, here called concepts. Figure 15 shows the presentation of a conceptual design, with initial evaluative indicators in the form of pluses and minuses. The Syllabus Maker concept envisions a single integrated tool for the creation of a syllabus that directly indexes into the library items needed by the students for the class. Despite these and other advantages of this concept, it is important to note that the advantages are not necessarily free—there are disadvantages as well, with faculty having to learn a new system, and without a concept to address non-digital materials. The concept is a developed idea but not a high-confidence solution.

Concept: Syllabus Maker

- Syllabus maker: faculty use library system to create syllabus with integrated reserve materials. Students look at syllabus, click one link, and are at the right location in the right item.

  + gives students one place to look--unifies disparate documents
  + gives students quick, direct access to course reserves material
  + in graphical form, can provide a rich time-based context for the course reserve materials

  – faculty have to learn a new system beyond a word processor
  – assumes all or most desired materials are available on-line; may overburden library staff

Figure 15. Sample concept presentation.

Multiple attractive concepts are combined into a system of concepts. Figure 16 shows one such system of concepts, as a conceptual sketch. In this system of concepts, the Syllabus Maker concept from Figure 15 is combined with other task-specific interfaces to digital library functionality into a comprehensive digital library system to support teaching and learning for a variety of users' access to a variety of collected materials, whether personal, institutional, or public.

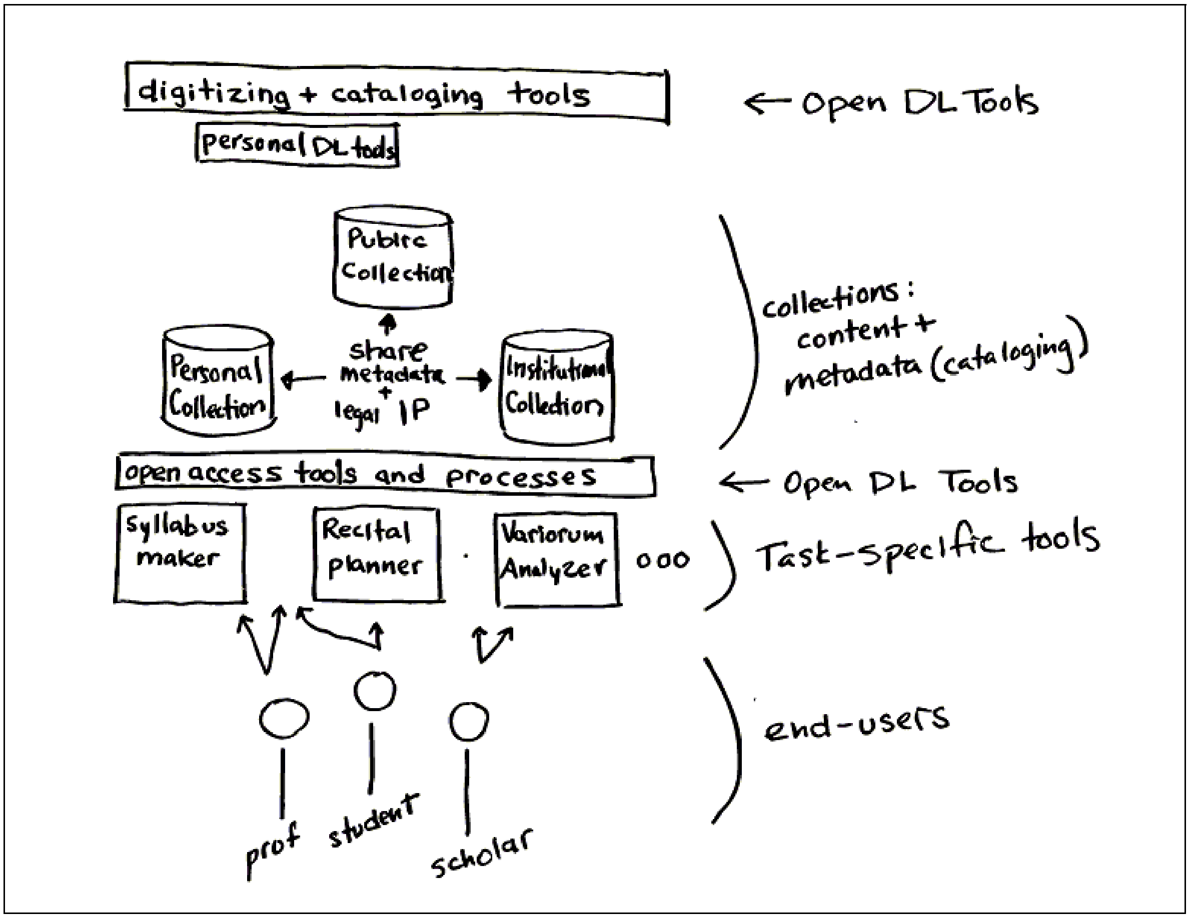


Figure 16. Sample system of concepts.

Once a system of concepts has been worked out, prototypes of three kinds can be created: (a) exploratory (or behavioral)—these are low-fidelity prototypes, (b) working—functional prototypes illustrate how the system will actually operate, and (c) appearance prototype—appearance prototypes can express the visual or industrial design of a product, showing how it will look. Figure 17 shows one appearance prototype created to show what a syllabus created with Syllabus Maker could look like. In the appearance prototype, the metadata available from the library is used by the system when the instructor selects music for the course syllabus. The date information enables the system to create a timeline of the works of music and the composers' life spans to relate the content timeline to the course schedule (week 8, week 9) while also providing direct access to the works of interest using clickable icons.

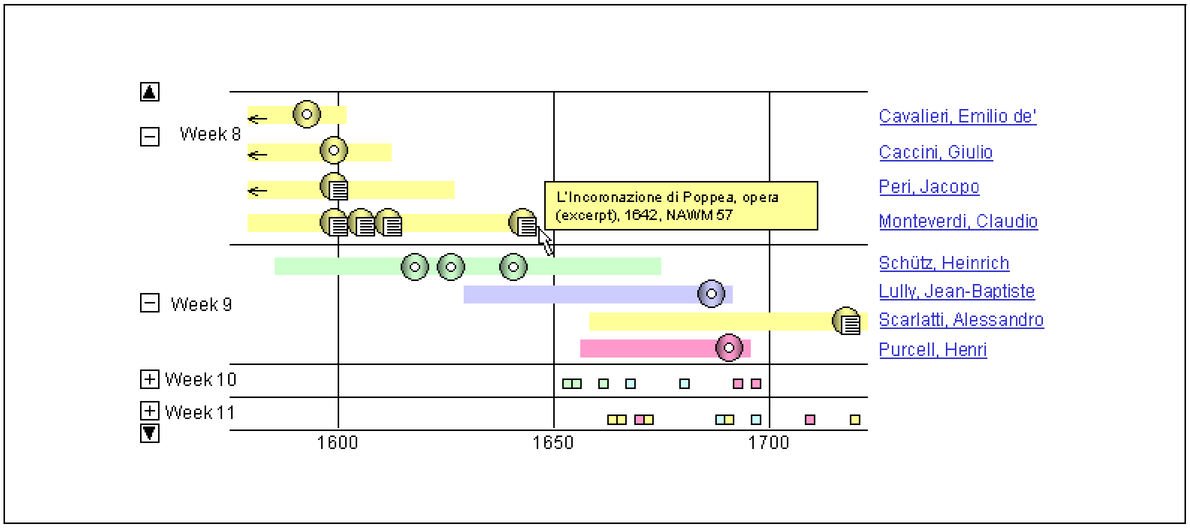


Figure 17. Appearance prototype.
From "Variations2: Toward visual interfaces for digital music libraries" by M. Notess & N. Minibayeva, 2002, September, Paper presented at the Second International Workshop on Visual Interfaces to Digital Libraries at the ACM+IEEE Joint Conference on Digital Libraries, Denver, CO.

The final step of PRInCiPleS is the formation of a strategy for implementation that does not neglect technological possibility, enterprise viability, and social value. PRInCiPleS is not specific about how to form this strategy—it merely states that such a strategy should be constructed. In the case study, the implementation strategy developed is shown in Figure 18.

Implementation Strategy

For Integrated Syllabus:

- Technology: Add a tab to the existing Variations2 search window, “Course,” that allows students to browse or search for their class syllabus. The syllabus uses Java 2D graphics to display the timelines, hyperlinks, icons, etc. Store course-specific data in repository with bibliographic data. Long term, explore integrating with OnCourse web services architecture.
- Enterprise: Propose to Variations2 technical team. Identify several courses to pilot the technology. Present to music library reserves team, faculty and graduate assistants.
- Social Value: Save students time in locating course materials.

Figure 18. Sample strategy presentation.

In the end, the proposed implementation was not carried out as part of the Variations2 project because of other priorities. However, the design idea is at least in part still under consideration as part of a follow-on project.

Comparison and Compatibility

The present case study illustrates one possible integration of CD techniques and the PRInCiPleS approach. In some respects, CD and PRInCiPleS are parallel but distinct design methods and can be compared as such. But because of a difference in level of specificity as to how a given step is accomplished, and because of the similarity in the steps offered by the two methods, CD can also be examined as a possible means of implementing at least part of PRInCiPleS. This section begins with a side-by-side comparison of the two methods in parallel and then turns to an examination of the integration that is possible.

CD and PRInCiPleS have significant similarities. The list below summarizes commonalities.

1. Both provide a set of steps moving from initial observation data through an analytical activity, through a redesign activity, to prototype artifacts, which can be used for communication and validation.

2. Both begin with an initial identification of a target population and focus of attention for exploration of that population.

3. Both use field observations and artifact collection and analysis to understand the target population.

4. Both emphasize chains of reasoning to keep the design process coherent and data-based.

5. Both rely on creative leaps to generate design alternatives from contextual understandings. In CD, this occurs in the *work redesign* step, in PRInCiPleS in the transition from *insights* to *concepts*.

6. Both use iterative refinement through prototyped interventions.

Despite these similarities, CD and PRInCiPleS also have some notable differences. The list below summarizes these differences.

1. CD emphasizes a rigorous team process—indeed the necessity of working in an interdisciplinary team—whereas PRInCiPleS does not insist on a team effort nor specify how a team should operate. Even the scaled-down versions of CD presented in Holtzblatt et al. (2005) assume a team of at least two participant-designers. The present case study was carried out by just one participant-designer.

2. CD specifies the use of well-defined, detailed representations of user data and system design. PRInCiPleS does not specify what representation to use for these data and designs.

3. CD representations are geared toward providing detailed data for the design team; PRInCiPleS lends itself well to creating compelling communication of design arguments via slide sets and presentations.

4. PRInCiPleS requires a design to be defended along a triumvirate of dimensions: technological possibility, enterprise viability, and social value. CD is centered in user needs and does not directly address these dimensions.

5. PRInCiPleS is more a rhetorical framework than a design method. The order of the argument need not dictate the order of the design work. For example, the *predispositions*, which come first in the argument, did not emerge in the case study until after the observational research was conducted. CD steps are ordered.

The most striking difference between the methods is not the methods themselves but the assumptions about the skills of the people who use them. For example, CD is designed for people whose formal design training may not have been human-centered at all: “In our approach to process design, we recognize that much of what we do is to make explicit and public things that good designers do implicitly” (Beyer & Holtzblatt, 1998, p. 21). PRInCiPleS assumes its practitioners are working more in a studio-based design tradition, where certain behaviors are assumed, such as concept enumeration: “One of the most salient features of design culture is the ability of its learners and practitioners to generate many divergent concepts and the willingness to discard concepts” (Blevis, Rogers, Siegel, Hazlewood, & Stephano, 2004). PRInCiPleS assumes standard design techniques for generating concepts. Neither does it specify the techniques to be used to explore contexts of use or represent data. CD assumes its practitioners need to have appropriate techniques prescribed and offers detailed instructions for their use.

This contrast in level of specificity and prescription makes a side-by-side comparison of steps potentially misleading. Table 7 shows the correspondences between the two methods, but this is not a table of equivalences. In each case, the CD methods on the left-hand side are potentially ways to accomplish the PRInCiPleS steps on the right-hand side. For example, CI is one method for doing the PRInCiPleS research step. However, other or additional research methods could be used with PRInCiPleS, such as ethnography, diary studies, and literature review. Work modeling and consolidation is the CD technique for generating the insights that lead to design concepts, and the work redesign (visioning, storyboarding) and UED steps from CD serve to generate and express concepts and systems of concepts. Yet again, as with paper prototyping, these CD techniques can accomplish the PRInCiPleS elements, but not uniquely nor even fully. For instance, PRInCiPleS prototypes include working and appearance prototypes; CD focuses on low-fidelity prototypes. PRInCiPleS is likewise broader than CD in that it addresses predispositions and strategies, neither of which has an explicit equivalent in CD.

Table 7
Compatibilities Between Contextual Design Steps and PRInCiPleS Elements

Contextual Design	PRInCiPleS
	predispositions
contextual inquiry	research
work modeling consolidation	insights
work redesign user environment design	concepts & concept systems
paper prototyping	prototypes
	strategies

Conclusion

This case study demonstrates one combination of CD and PRInCiPleS. Other combinations can be imagined. For instance, one could follow the full CD process but add the predispositions and strategies elements from PRInCiPleS. There are no inherent conflicts in the steps and elements of the two methods. However, some of the values from PRInCiPleS could serve to strengthen CD as a method. For example, CD could do more to enumerate predispositions, ensure the world of possible concepts is fully explored before moving ahead with a system design, embed design ideas and system proposals in business-digestible strategies, and create a concise, coherent design argument.

It is these latter two issues—team and scale—where the design community can learn the most from CD. In a large information systems project, a designer may feel marginalized by the technologists. There is a strong bias amongst technologists that problem solving moves rapidly from problem identification to a solution. The designer, by contrast, often wants to seek a broad-based contextual understanding and explore a wide range of alternative interventions iteratively before settling on a design. CD offers non-designers a step-by-step method for participation in a more studio-like process. Most important, CD enables all project participants to arrive at a shared understanding of the needs and characteristics of the target population.

The crucial difference between CD and PRInCiPleS lies in the level of designerly skill residing in the practitioner. PRInCiPleS assumes a studio-trained designer who can select and adapt appropriate techniques to achieve the elements of a coherent design argument. CD provides more of a step-by-step set of instructions, enabling participation by those not trained in design, even though a skilled designer seems to be required to lead the process. CD also provides guidance on executing a design process as a team. This case study was not team-based, but combining CD and PRInCiPleS in a team setting might uncover additional benefits of the combination of methods.

If nothing else, this chapter raises a key question to be explored in the chapter five study of how CD is used by practitioners: do people who have learned CD follow it at a detailed, step-by-step level even after they have become skilled designers? Or do they tend to use it more as a mnemonic, a reminder of what principles are important to include in any design process, regardless of which techniques are selected?

4. CONTEXTUAL DESIGN MODELS AND THE REPRESENTATION OF LEARNING ACTIVITY

Introduction

The practice of collecting observational data on real work practice and representing those findings during design has become commonplace in user-centered design activities. Techniques for representing qualitative field data vary greatly, ranging from purely textual descriptions to formalized diagrams, to combinations of text and diagram. This chapter looks at the motivation for the formalized, diagrammatic models of CD and their potential utility in the design of educational technology. The kind of data represented in each of the five work-model types is analyzed and illustrated, and the adequacy of the models for the domain of education is also assessed. The chapter concludes with a summary of the utility of CD work models in representing learning activity and identifies areas for further research.

To ground this analysis and provide some basis for assessment, the following design project scenario is used throughout:

> A consortium of universities wants to develop software to make it easier to integrate digital library items into instruction. They are particularly interested in the use of non-textual, creative artifacts such as recorded music, scores, video, art images and photographs. They apply for and receive a grant from a foundation, funding a design team to investigate the issues and come up with a prototype. Here are some of the questions the design team initially wants to answer.
>
> 1. How are such items used in teaching and learning today, either with or without computer technology?
>
> 2. What difficulties do instructors or students encounter?
>
> 3. What opportunities exist to improve instruction by providing better technical solutions?

4. How similar are these usages, difficulties, and opportunities across different instructors, courses, disciplines, and institutions?

Among other research methods, the design team decides to use CD to address these questions. Is this a wise decision? Will the CD models provide a good way of getting at an answer to the last question?

The remainder of this paper examines the likelihood that CD models address the last question in this scenario well.

Background

At the front end of the CD process, the design team carries out multiple contextual inquiries and then interprets the data into five types of diagrammatic work models. Models representing individual inquiries are later consolidated to provide a synthesized view across all the observations. Beyer and Holtzblatt offer two primary reasons for representing work diagrammatically (1998, pp. 83–86). First, the work modeling language as a formalism helps stakeholders understand the work that a product is intended to support. Most, if not all, of these stakeholders do not have a professional background in analyzing and understanding work. A formal language for describing work gives stakeholders a common way to understand and talk about the user data. Second, using diagrams rather than simply text allows the work patterns to be perceived holistically and immediately, speeding the design process. Representing work patterns graphically makes them more visible, coherent, and sharable.

The diagrammatic work models of CD stand in contrast to the usually textual representations used in other HCI design methods such as scenario-based design (Carroll 1995, 2000; Rosson & Carroll, 2002), personas (Cooper, 1999), and ethnographic methods generally. Despite the relative popularity of CD within the HCI community, the models themselves are rarely published and have not been formally assessed nor even rigorously described outside the two CD books, where the treatment is instructional rather than analytical. As a result, it is not easy to judge how effective CD work models are at accomplishing either the above communicative objectives, nor is it easy to assess the comprehensiveness or the utility of their inherent representational expressiveness.

Educational Contexts

From the examples in the CD books (Beyer & Holtzblatt, 1998; Holtzblatt et al., 2005), it seems clear that CD work models were developed primarily to represent office or technical work in professional environments, particularly where such work involves or can involve computers. Although much learning-related work practice may be similar to office work, a major difference is that the goal is learning, whereas in an office environment learning tends to be incidental to the accomplishment of other tasks. Kinds of work used as extended examples in the first book include secretarial work, technical documentation, technical support, system and network administration, and analytical laboratory work (Beyer & Holtzblatt, 1998).

The more recent book does offer some insight into applying CD in educational contexts because it uses some work done for a K–12 company called eChalk as one of several extended examples throughout the book. However, the focus of the eChalk example is on communication between teachers, administration, parents, and students but not on learning *per se*. Thus when eChalk data are used to demonstrate sequence modeling, the examples show activity less about learning and more about office work: a teacher creates a communication with parents about a student misbehavior incident (Holtzblatt et al., 2005, pp. 154–155). Other kinds of work used as extended examples for the second book are again analytical laboratory and systems/network administration, customer relationship management, and business-to-business purchasing.

Contribution of this Chapter

The contribution of this chapter is twofold. In providing a rigorous analytical accounting of the CD models, the expressiveness and utility of the models become open to evaluation. Once open to evaluation, the models can then be examined with respect to learning activity. This chapter provides an initial step toward assessing the suitability of CD models in representing and communicating learning activity. The step is initial because many fuller accountings are possible, where the modeling constructs are compared against the learning activities as defined by or of interest to different learning theories. This chapter is not restricted to the interests of a particular learning theory but instead offers an initial critique, based on the scenario given above, of how well the models represent a range of learning activities, with theory-based concerns mentioned where relevant.

The Models: Analysis and Critique

Method

In CD, researchers observe work as it unfolds in its normal context. Researchers also ask clarifying questions to explore the hypotheses they are forming about what is going on and why. After gathering data in this manner, the data are represented in five diagrammatic work models. Initially, data from each observation session are used to create a set of models showing only that session. But after all (or some) of the individual sessions have been modeled, the individual models are consolidated across the sessions. For the purposes of describing and illustrating each type of model, this chapter uses consolidated models because they tend to be more complex and interesting, and therefore more likely to illustrate all the features of a given model type. Where the representational conventions of consolidated models differ significantly from single-session model conventions, those differences are identified.

A potential difficulty with this study is deciding on the definitive source of information about CD models. The explanations in the original CD book (Beyer & Holtzblatt, 1998) are the most widely known, so those are the definitions followed in this analysis. But variant definitions, mainly more elaborate ones, may be found in the training materials from InContext Enterprises, in the more recent “rapid CD” book (Holtzblatt et al., 2005), or in summary treatments by other writers (e.g., Preece et al., 2002). For example, the newest CD book describes ways of using blue, red, green, and black markers to draw the work models, with each color having its own meaning (Holtzblatt et al., 2005, p. 130). The original CD describes using red to indicate breakdowns but does not introduce a more elaborate color scheme.

Each CD model captures observable attributes of work. In the tables below, each model is described in terms of the attributes of work it captures, the form of the representation, and one or more examples of what an attribute could represent in an educational context. The first two columns in these tables were derived from a careful analysis of both the textual descriptions and the drawn models in the CD book. The terminology used for work attributes closely follows terminology used in the CD book itself. After each table, a diagram (or part of one) is given to illustrate the model itself and also give a sense of how the model can be used by designers. For each model, its utility in addressing the scenario described above is critiqued according to what can be easily and effectively represented, as opposed to what is difficult or impossible to represent with the given constructs.

The consolidated models were created during the contextual study described in chapter 3 (14 observations of 4 graduate voice students in a variety of contexts, but primarily in a music library).

Flow Model: Analysis and Example

The flow model describes the roles and responsibilities in a given work context, along with the flow (movement) of information and artifacts in that environment (see analysis in Table 8). Each role is a title in a circle, which also contains a list of the responsibilities that accompany that role. Roles may be individual (instructor, student, colleague) or collective (music library). A given role can be filled by more than one type of person. For example, an instructor role may be in part filled by a graduate assistant with responsibility for grading. Thus, in a consolidated flow model, the circles represent roles rather than individuals (instructor rather than Professor 1).

Between the roles, communication and artifacts flow. These are represented by uni- or bidirectional arrows indicating the flow and a label indicating what information the flow carries. Artifacts are written in all capital letters and put inside a box, to distinguish them from non-artifactual communication such as speaking. A student asking another student for help in the library would be communication whereas the piece of paper upon which the instructor describes an assignment is an artifact. In addition to roles, flow also happens between places. In Table 8, a place is somewhere either physical or virtual that people go into or out of to accomplish work, such as a bulletin board or an online discussion forum. These are represented by boxes instead of circles. In all models, breakdowns are indicated by a red “lightning bolt” and a label describing the observed failure. For example, if the student looks for the class syllabus online but cannot find it, that is represented as a breakdown in the flow of information from the instructor to the student.

Table 8
Flow Model Analysis

Attribute	Representation	Examples
Role—a title for a collection of responsibilities fulfilled by a person or group of people.	Titled circle	instructor, student, colleague; can also be a collective role filled by an entity, such as “music library”
Responsibility—one or more of these defines the role.	Bullet points in the circle, under the role title	assign grades prepare syllabus
Flow—the communication or artifacts that move between roles to accomplish the work.	Uni- or bidirectional arrows between circles, labeled either with plain text (communication) or all-caps text in a box (artifact)	ask for help (communication); assignment (artifact)
Place—somewhere (physical or virtual) people go into or out of to accomplish work.	A titled box, also containing bulleted responsibilities.	a bulletin board; an online discussion forum
Breakdown—a failure in communication or coordination of the work.	A red lightning bolt, labeled with a description of the failure.	students can’t find syllabus online

The sample consolidated flow model (see Figure 19) shows the flow of information and artifacts between the voice student and other people who are part of the student’s learning environment. For an example that includes “places” as well as roles, see Figure 19. In this example, the preponderance of flow is between the course faculty role and the voice student role, with the former providing syllabi, assignments, examination study guides, examinations, and graded work to the student, in addition to the verbal, in-class communication of the lecture, questions, and short exercises. The student in turn submits homework, papers, and exams to the course faculty and both asks and answers questions. A breakdown shown in this model is the failure of the student who looks for a piece of music in the music library but is unable to locate it where the voice teacher said it would be.

Note the effect focus has on the data: of the many interactions observed during the student’s voice lesson, only one was related to library materials. The other interactions are not captured in this model because they are outside the focus for the project. Another consequence of focus is that the student is at the center, providing a holistic picture of only the student's interaction with library materials. It is not a holistic picture of how faculty interact with library materials to prepare syllabi, assignments, or exams.

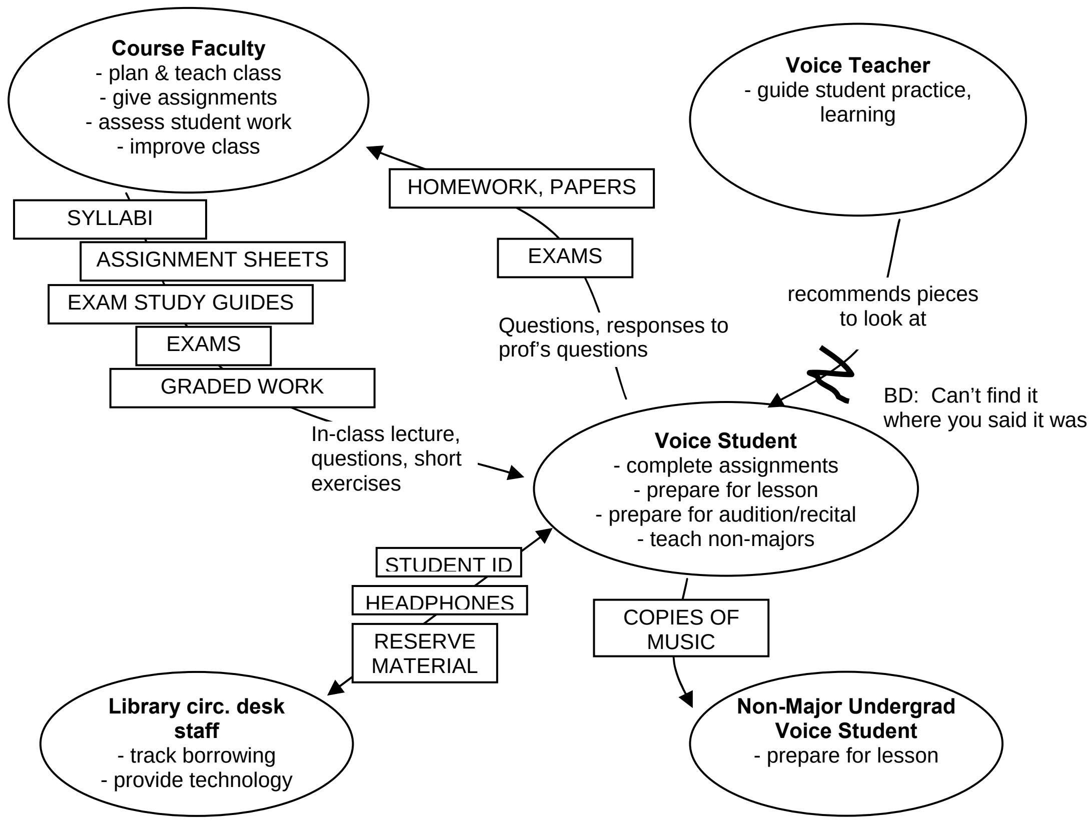


Figure 19. Consolidated flow model.

As mentioned earlier, the key difference between a single-session flow model and a consolidated one is that the circles represent generic roles rather than a specific person, who is labeled with a code such as U1 or U5 (see Figure 19).

Flow Model: Critique

Examining this model in light of the framing scenario, one finding of interest is that faculty activity drives much, though not all, of students' use of library materials. This recognition might cause designers to focus on how faculty create instructional artifacts, prepare for and deliver lectures, and particularly how faculty (and voice or instrumental teachers) specify library materials. But the focus of the designers might also shift to some of the less obvious student uses of the library such as identifying materials for their own students or preparing for auditions and recitals.

The flow model captures gross-level transactions fairly well. For example, course faculty deliver in-class lectures, they ask students questions, and they require short in-class exercises of the students. Students may reply to the instructor's questions or pose questions of their own. This gross-level capture is probably adequate even for studying educational contexts. It does not convey the fine-grained interaction between faculty and students in the classroom, but the sequence model (see below) is perhaps the better choice for representing those interactions.

Complex classroom interactions may challenge the capabilities of the flow model. The voice student study only included one classroom observation, and it was not a computer-equipped classroom. To illustrate how a flow model expresses classroom interaction, data from another contextual study that included interaction in a high-technology classroom is used. Here is a summary of the work being modeled.

> U1 displays a musical score and tells the students to work in groups for five minutes to make a list of things they see in that piece of music. Then U1 asks them for their answers and the groups start listing the features they noticed. As they mention the features, U1 comments on them and types some of them into a program that displays on the screen at the front of the classroom. U2 takes notes during the discussion. After class, U1 puts the list on the course website so students can download it.

Figure 20 shows the single-session (unconsolidated) flow model for just this portion of class activity. No breakdowns were recorded for this observation.

This flow model suggests two concerns. First, the model for a classroom interaction taking only five sentences to describe is fairly complex. A model for a full class session adds no people, a few places, but more responsibilities and much more "flow." The use of the projection screen by multiple devices (in this classroom two kinds of computers, a document camera, and an overhead projector), as well as several methods of generating music (piano, CD player, streaming audio on a computer, and having students sing) can add complexity. Simultaneously, the model needs to show the variety of information flowing in the classroom.

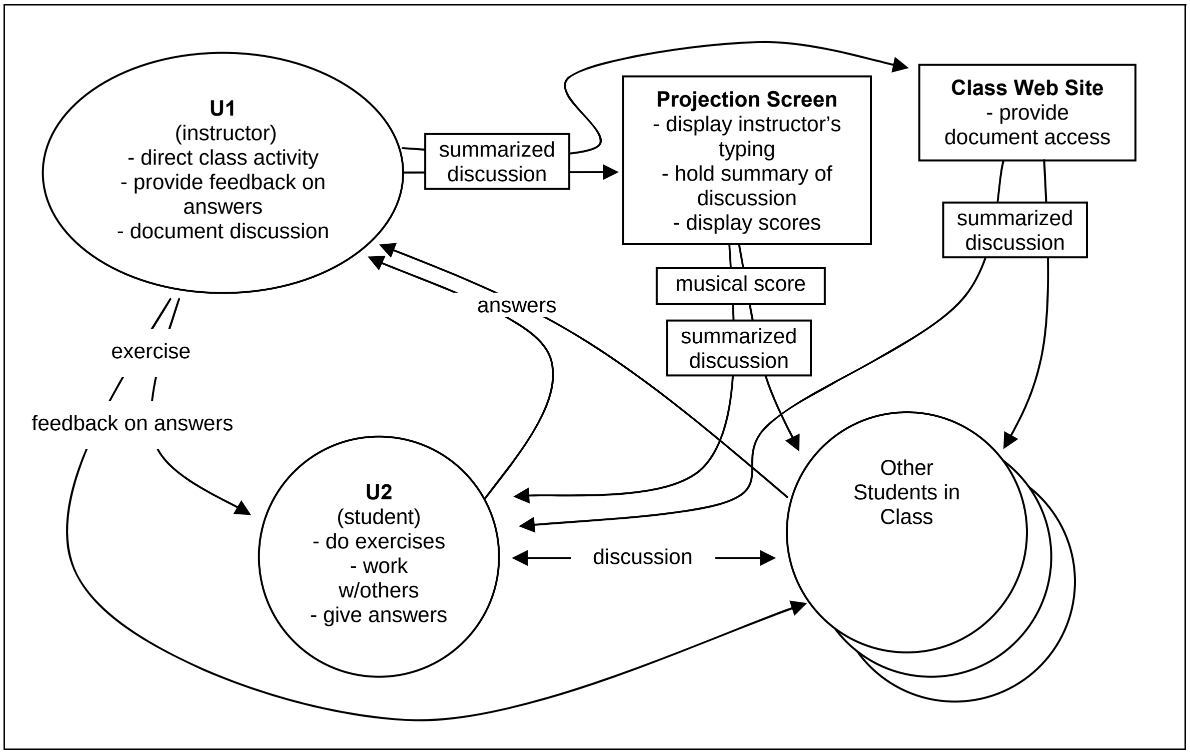


Figure 20. Partial session flow model.

The second concern this diagram raises pertains to learning. The main business of the classroom is, presumably, learning. Yet where is the learning in this model? Certainly the roles and responsibilities suggest where learning may occur. But the responsibilities listed for U2 say nothing about learning, regardless of whether one adopts a cognitivist "information processing" definition of learning or a social-constructivist stance. One might guess at where the learning occurs, but it would only be a guess. Put another way, if something—spoken communication or an information-bearing artifact—flows to me, what have I received? Have I learned something? This question may be vitally important when designing systems for educational use, yet CD models can be almost behaviorist in their emphasis on observable activity. Yet CD is not behaviorist. CI captures *intents*, the goals people are trying to accomplish. Research in learning has found that not all students bring the same intentions into the classroom. Some students (at some times) take a "surface" approach, merely trying to get through and get the grade or degree. Other students, or the same students at other times take a "deep" approach, where they more fully engage, with an intention of learning the material (Entwistle, 2000). In Figure 2, U2's responsibilities could be interpreted as a surface approach, but it is difficult to be certain by watching. A detailed discussion of intents (which did not occur in this particular CI session) might yield responsibilities such as “learn the material.” But it is the sequence model (see next section), not the flow model, that expresses intents. The relationship between responsibilities and intents is not represented in either the flow or sequence model, although these relationships could be shown as cross purposes in the culture model.

From this model, the designers in the scenario would see one place for digital library artifacts to appear: on the projection screen. However, this model does not provide sufficient information about the detailed interactions with the music score (instructor pointing, students looking) to guide design of any score presentation tools that would support learning. The designers would have to look to other models such as sequence, physical, or artifact to inform their design.

Sequence Model: Analysis and Example

The sequence model is the model with the most analogs in other HCI approaches because it is a form of task analysis. The HCI textbooks commonly teach hierarchical task analysis using inverted tree diagrams or multilevel outlines to express how a particular task is organized and sequenced (e.g., Preece et al., 2002, p. 232). The CD sequence model organizes task steps into sequences triggered by environmental events (see analysis in Table 9). In response to a trigger (an assignment being due), the user forms an intent (e.g., complete assignment) and attempts to fulfill it with a sequence of steps (log in, find piece to listen to). Apart from simple sequence—one step following another—simple parallelism or (in the case of the consolidated model) alternative strategies can be represented using indentation or multiple columns. Apart from these layout conventions and the usual red lightning bolt indicating a breakdown, this diagram is almost entirely textual. In this diagram, a breakdown is the failure of a task step to produce the desired or expected outcome.

Table 9
Sequence Model Analysis

Attribute	Representation	Examples
Intent—the result someone is trying to achieve by a sequence of actions.	A short, imperative statement, prefixed by “Intent:” or in a column labeled “Intent”	“Intent: complete assignment”; “Intent: prepare for exam”
Trigger—a perceived event or condition, often external to a person, provoking an intent.	A short statement of an event or condition, prefixed by “Trigger:”	“Trigger: time for class to start”; “Trigger: assignment due tomorrow”
Task step—at various levels of abstraction, a step in accomplishing an intent.	A short, imperative statement; separated by arrows in the single session version (see Fig. 3)	“Log on computer”; “Find piece to listen to”
Structural indicators—columns separating high-level activities from intents and from abstract steps; also use of columns to indicate parallelism or alternative strategies.	Vertical columns	(See Table 10)
Breakdown—a failure of a task step to produce the expected or desired result.	At the end of the relevant abstract step, “BD:” prefix and a statement of the failure.	“BD: Forgot to bring assignment sheet to library.”

BD = breakdown

Table 10 shows a consolidated sequence model for one observed activity, “prepare to do library work.” This fragment of a larger model is revised and expanded from one previously published (Notess, 2004b). One intent supporting this activity is to locate the online recording with which the student needs to work. The triggering event, provoking the activity in the first place, is that the assignment is due soon. The abstract steps show two alternate strategies students followed to get to the Variations web page. Either students navigate to the item from their online course reserves list, or they type in the URL for the item that is printed on their assignment sheet. Once on this page, students click on the desired side or CD in the set to launch the audio player.

Table 10
Two Activities from Consolidated “Study in Detail” Sequence

Activity	Intent	Abstract Step
Prepare to do library work	retrieve known recording	Trigger: assignment is due • Find online course reserve list • Scroll to desired recording (BD: reserve list may be very long) • Select item (BD: easy to pick wrong item due to title similarities) (or) • Looking at assignment sheet, type Variations URL for item in browser field (BD: forgot to bring assignment sheet to library) • Select CD/Side on Variations web page
Work with library materials	study material	• set “always on top” for Variations window (optional) • find right track within recording, using “next track” or by moving slider and watching names of track fly by (BD: hard to find right track) • listen • follow along in score and/or song text • repeat whole piece (set auto-repeat of one track) or repeat key parts (move slider back to approximately right place) • stop playback when piece is over
	make personal notes to capture key points gleaned from studying	While listening, do any of the following • type notes in word processor or write on paper • look up details in catalog record to include in assignment or for own curiosity • after awhile, pause or stop recording so it doesn’t interfere with writing.

BD = breakdown

The consolidated sequence model differs from the single-session sequence model in having a three-level hierarchy. The single-session sequence model, which is shown in Figure 21 in the next section, is a flat list of very concrete task steps, annotated with “intent” labels. Also, when a sequence model represents only one observation, there is no need to indicate alternate strategies.

Sequence Model: Critique

Designers in the scenario, looking at the first activity in Table 11, might conclude that while some people are comfortable navigating to and locating an item online, others prefer to pay the price of entering a long URL as a means of either avoiding the navigation or remembering how to accomplish it. They might also note the persistence of paper and decide whether to accommodate a preference for paper documents on the part of some faculty, or to take on the battle of moving all assignments online. Finally, they might look into making long reserve lists easier to browse. Looking at the second activity in Table 10, designers might attend to issues of window management, navigation in the online recording, synchronization between the audio and other media (score, song text), and the interplay between listening and writing notes to oneself.

In the second activity in Table 10, the abstract steps are only loosely sequential, nor are all required. Students do have to find the right track in the recording before they can listen, and they have to start listening before they can stop, but other steps listed under “While listening, do any of the following” can be done in parallel with listening and need not themselves be sequential. Furthermore, not all students set the “always on top” option to keep the audio player window in the foreground. The CD sequence model offers no documented way to represent parallelism, randomness, or optionality, but it is not difficult to invent conventions for each of these that work reasonably well.

As with the flow model, the sequence model seems adequate for capturing work data at the paper-and-window-shuffling level. But there are two areas where the sequence model is less helpful. The first is in capturing the complexity of intents. Beyer and Holtzblatt (1998) described intents as though they were simple, hierarchical, and straightforward.

> The intent defines why the work represented by a sequence matters to the user at all. Every sequence has a primary intent, which applies to the whole sequence. Then there will be secondary intents, which drive the particular way the work is carried out. (p. 101).

The model in Table 10 expresses both levels of intents. At the top level is the sequence itself: “study in detail.” At this level there seems to be no difference between titling the work sequence itself and describing the intent of the work. The secondary intents are those in the center column, “retrieve known recording,” “study material,” and “make notes.” Both of these levels are problematic. The primary intent does not explain the reason for the intent. Why do students want to study something in detail? Why does this work “matter”? Data from the voice students themselves place “study in detail” within several larger activities. A student could be completing a listening assignment for class—having to listen carefully enough to have something reasonable to say. Or a student could be working on a major, full-semester paper for a class—having to listen carefully to decide which performances of a song to analyze and to get ideas about what to say in the paper. Third, the student might be preparing a song to use in an audition—having to listen carefully to decide which performances are most interesting and instructive, and to help with interpretation. Finally, the student could be preparing for an exam—having to listen carefully to multiple songs, taking notes on the prominent or distinguishing features in order to identify the songs on the exam.

Strictly speaking, these larger motivations for library listening work are outside the focus motivating the original contextual study. And so, rather than having separate consolidated sequence models for each type of activity above (e.g., “preparing for an audition” or “studying for an exam”), the consolidation is based on the pattern of material use in the library, regardless of the larger activity of which such use is a part. Yet these larger activities, which explain why the work “matters” to the students, are themselves motivated by the desire to accomplish still larger activities, such as passing a class, getting a degree, or becoming a voice teacher or professional singer. In a business context, these motivations might be “advance in my career” or “lead a successful project.” Although higher-level motivations may not be directly relevant to the focus of the contextual study, they provide a kind of context for the data that is not well-captured in any of the work models.

This hierarchy in intents and activities raises the question of what the difference is between intents and activities. Taken at face value, an intent is an internal goal or motivation and an activity is something someone does. The distinction seems clear. But in the model, “retrieve known recording” would seem to be as much of an observed activity as “find online course reserve list.” If intents are usefully represented as activities, then the distinction is more arbitrary and there is very little difference between a sequence model and a hierarchical task analysis.

If looking “up” the task hierarchy from the sequence model raises issues, so does looking “down.” The second area where the sequence model constructs are not as helpful as may be needed is the expression of detailed, largely cognitive activities. For example, one of the abstract task steps in Table 10 is “type notes in word processor or write on paper.” This is a step happening in parallel with another step, “listen.” Listening and writing things down is the heart of the observed learning activity, yet this model expresses very little about it. Again, it could be that such details were outside the focus of this study, but in fact they were not. The scenario is concerned with how students work with library materials, not just how they locate them, retrieve them, or arrange them on their desktop. Of course, when a student is sitting at a computer carrel in a library, listening to music with headphones on and typing in a word processing program, researchers would not want to interrupt the student’s activity to ask about what the student heard and thought when writing each comment. They would wait until the activity is over and then ask the student about the artifact produced and see how well the experience can be reconstructed *post hoc*. After one observation, the researcher asked the student what sorts of things he wrote in his assignment. He answered by providing a list: comparison, quality, song fit with the language it’s in, analysis of what’s hard and why, subjective reaction, whether he would sing or teach it, and appropriate voice and gender for performance.

Any of these heuristics, or other unarticulated ones, might be in play at any time while the student is listening and writing. Where are these captured? They do not fit well in any of the work models. Certainly it would be possible to try writing a sequence model for “analysis of what’s hard and why,” trying to reconstruct the perceptual and cognitive steps involved in making this determination, but CI along these lines is probably out of its depth. The best approach may simply be listing all of these heuristics as abstract steps in the sequence model. Yet it is not clear where to list them—under the “listen” step or as part of the “write” step. Moreover, the consolidation would be tricky because of the already mentioned variety of larger activities in which listening and writing are embedded. The heuristics one uses for listening and writing might be somewhat different if one is studying for an examination or writing a long analytical paper, and these differences would argue for separate sequence consolidations.

As with the flow model, sequence models also have more difficulty capturing the dialogic classroom setting. Figure 21 shows a single-session sequence model for a classroom activity several minutes in length. The sequence shown in the model can also be described textually as follows.

> The instructor displays a score transparency for an art song on the overhead projector. He tells the students that this song is a masterpiece of text-painting. He tells them that, when they listen, they will use a process to make notes about examples of text-painting—he draws a two-column table on the board that says "Voice" on one side and "Piano" on the other. He wants them to look at text painting and distinguish piano from voice, and score from interpretation. Then he walks over to the stereo, punches a couple of buttons and the song plays. As the song plays, he moves the score up so they can see the bottom of the page. When it is over, he turns down the volume control and asks for examples. Students mention some, and he gives them comments on their answers, adding his own thoughts about the piece. He illustrates some of the piano text painting by pointing at the score and singing the piano part. He comments that this would be a good interpretive piece for a young singer.

Intent: help students appreciate & become more attentive to text painting; improve students' familiarity with another song composer

Trigger: This is the next composer in the syllabus, and he provides a good opportunity to illustrate text painting.

↓

Display transparency of score on screen

Screen is too small to display entire score page

↓

Explain that this is a good example of an important concept (text painting)

↓

Tell students to use table to take notes on voice and piano text painting as they listen

↓

Punch buttons on CD player to start song

↓

As song progresses, slide score up

↓

When song finishes, turn down audio volume

↓

Ask students for text painting examples

↓

Give feedback on answers, adding own thoughts

↓

Illustrate by pointing at score and singing piano parts

Can't point at score while playing on the piano

↓

Give advice for further study and usage

Figure 21. A single-session sequence model.

This sequence model, following the examples in the CD book, expresses one person's task: the instructor's. Yet the classroom is a dialog between the instructor and the students. To get a full picture, one would also have to create a separate sequence showing the student's task steps: write down song title, listen to instructions, write down blank table, listen to music while alternating between looking at the score and making notes in the table, listen to the teacher's comments, offer an answer, make notes on paper of some of the teacher's comments. CD models offer no way to bring these two sequences together into a single dialog. Another issue is that, similar to the issue noted earlier, there is not always a strict sequence to the core activity—classroom dialog about a piece of music. While it is true that the instructor organized and initiated the overall structure of the class session as well as the individual activities that constitute "class," our sequence model becomes overly simplistic when representing the idiosyncratic dialog structure that occurs. This oversimplification can be dangerous during design if a tool enforces a sequence arbitrarily.

Any consolidation of the student sequence models would also struggle to represent the hierarchy and multiplicity of intents present. For instance, the classroom observed in this scenario likely had a combination of at least the following intents for any given sequence: complete my classes so I can get my degree, impress the professor, become a better interpretive singer, add to the collection of songs I'm familiar with so I can pull them out for myself or my future students, stay awake, take good notes so I can do well on the final, and satisfy my intellectual curiosity.

Beyer and Holtzblatt (1998) acknowledged the multilevel nature of task sequences: "Sequences may be studied at any level of detail, from the high-level work to accomplish an overall task to the detailed interaction steps with a particular user interface" (p. 99). Picking the levels to study and represent requires expert judgment. Even so, the sequence model falls short in representing internal (cognitive) or dialogic activities.

Culture Model: Analysis and Example

The culture model represents the political and emotional influences operating in a work environment (see analysis in Table 11). Figure 22 uses opaque circles to indicate categories of "influencers", and uses position and amount of overlap to show the extent of the influence. Specific influences are labeled arrows between circles, showing the directionality of the influence. Labeled arrows also indicate "pushback" against an unwanted influences. Breakdowns in this diagram represent conflicting influences.

Figure 22 shows the consolidated culture model for all the voice student contextual inquiries. The circles indicate people or groups of people who have influence or exert pressure on the voice student, and who may receive "pushback" from the student. For example, course faculty decide what assignments to require, but students may become skeptical about some assignments, completing them just to get the grade. The voice teacher has the most influence on the student, though other faculty and famous singers also have considerable influence.

Table 11
Culture Model Analysis

Attribute	Representation	Examples
Influencer—individual or formal/perceived group.	A labeled opaque circle.	"Student"; "Instructor"
Extent of influence—the extent to which an individual or group influences the work done by another.	Overlap of circles.	(see Figure 22)
Influence—a standard, policy, value, emotion, style, etc. Can also be a pushback against an unwanted influence.	A directional arrow from one circle to another, labeled with a short description of the influence.	"Students need to be exposed to more than just classical music."
Breakdown—an influence that interferes with the work being accomplished; conflicting influences.	A red lightening bolt, labeled with a description of the interference.	"This assignment is a waste of time."

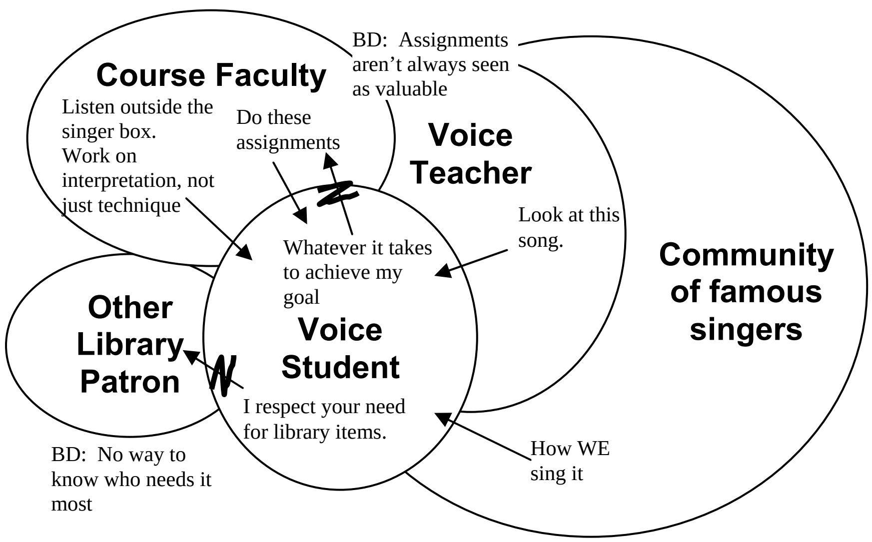


Figure 22. Consolidated culture model.

Other than the circles being representative of multiple people, there are no significant differences between the a single-session culture model and a consolidated one.

Culture Model: Critique

The designers from the scenario might note the relative simplicity of the culture, especially as compared with consolidated culture models from office environments where there seem to be many more groups and influences: more politics. Designers might ask whether there is a tension between the voice teacher's influence and the influence of other famous singers—mainly heard on library recordings—and think through the implications of changing that balance by making it easier to listen to more recordings. Designers could explore the difference between listening for technique and listening for interpretation. Are different tools needed? How easy is it to compare recordings at a detailed level? Finally, given that most library resources are not online and are therefore subject to resource contention, is there some way patrons can be made more aware of how much an item is used or whether someone else may want to use it—a finer-grained mechanism than simply recalling it?

One criticism of the culture model is inspired by Lave and Wenger (1991) who characterized learning, from an anthropological perspective, as the movement of a person from the periphery of a community of practice toward its center. Voice students for example, move from being just students who hope to get into the better campus ensembles or gain an important role in an student operatic production, to being professionals who can command a fee or a salary for their vocal performance or for their teaching skills. Along the way, students not only take academic classes and voice lessons but also plan and perform in recitals, sometimes teach voice to non-music majors for a fee, audition for both on-campus and off-campus opportunities, and otherwise participate in a high-pressure, competitive community. Learning is dynamic—a movement from being a student to becoming a performer and/or teacher. But the culture model is static, unable to represent the culture of *becoming*, which is central to any professionally oriented discipline in a university.

Lave and Wenger (1991) describe this dynamism: "*Changing* locations and perspectives are part of actors' learning trajectories, developing identities, and forms of membership" (p. 36, emphasis theirs). In the culture of a school of music or of art, theatre, law, medicine, or education, students chart idiosyncratic trajectories among the range of alternatives present in the profession. What may be needed is a model that expresses the movement that occurs within a culture as people learn.

Considering the scenario in light of this need, a question to ask is how patterns of movement compare across disciplines or institutions. How do the ways people use creative materials differ based on the identities they develop? How does interaction with the materials shape individual trajectories? For example, if students are listening to music online or hearing it in the classroom, what kind of difference does it make to see the album cover or liner notes simultaneously, or to watch a video instead of just hearing the audio?

Artifact Model: Analysis and Example

The artifact model shows the structure of objects created or used by people carrying out the work (see analysis in Table 12). The artifact itself is typically represented with either an annotated drawing of the artifact or sometimes with an annotated copy or photograph of the artifact itself. In the case of a course syllabus, for example, simply printing one or making a photocopy, and then adding annotations, is sufficient. However, when consolidating artifact models, drawing are usually necessary so that more generic representations can be constructed. The annotations, in the form of callouts or comments pointing to a part of the artifact, indicate the usage made of the artifact in the work practice. Breakdowns indicate a failure of the artifact to support the activity adequately. For example, if students have to retype a URL to access material, they may type the URL incorrectly.

The consolidated artifact model (Figure 23) shows one of the main artifacts observed in the study: the assignment sheet. The artifact depiction shows the types of content found on the observed assignment sheets: course number, instructor name, and assignment title, number or due date at the top, followed by instructions if needed and further identifiers of online material. Next to the depiction are annotations labeling the structure and describing usage and breakdowns. The model definition provides no specified way to indicate optionality, so instead text (“sometimes” or “if needed”) is used to indicate that not all elements are present for all assignments or all instructors.

Table 12
Artifact Model Analysis

Attribute	Representation	Examples
Artifact—something created or used in the course of the work. Artifacts are often formally structured into discrete parts, containing specific types of information in each part. People may adapt artifacts with informal annotations.	Varies, depending on the artifact.	a course syllabus
Usage—how the artifact is used to accomplish work.	Textual comments or callouts, pointing to the relevant part of the artifact.	(see Figure 23)
Breakdown—a failure of the artifact to adequately support the work.	A red lightening bolt, labeled with a description of the problem.	"Long URLs are difficult to retype correctly."

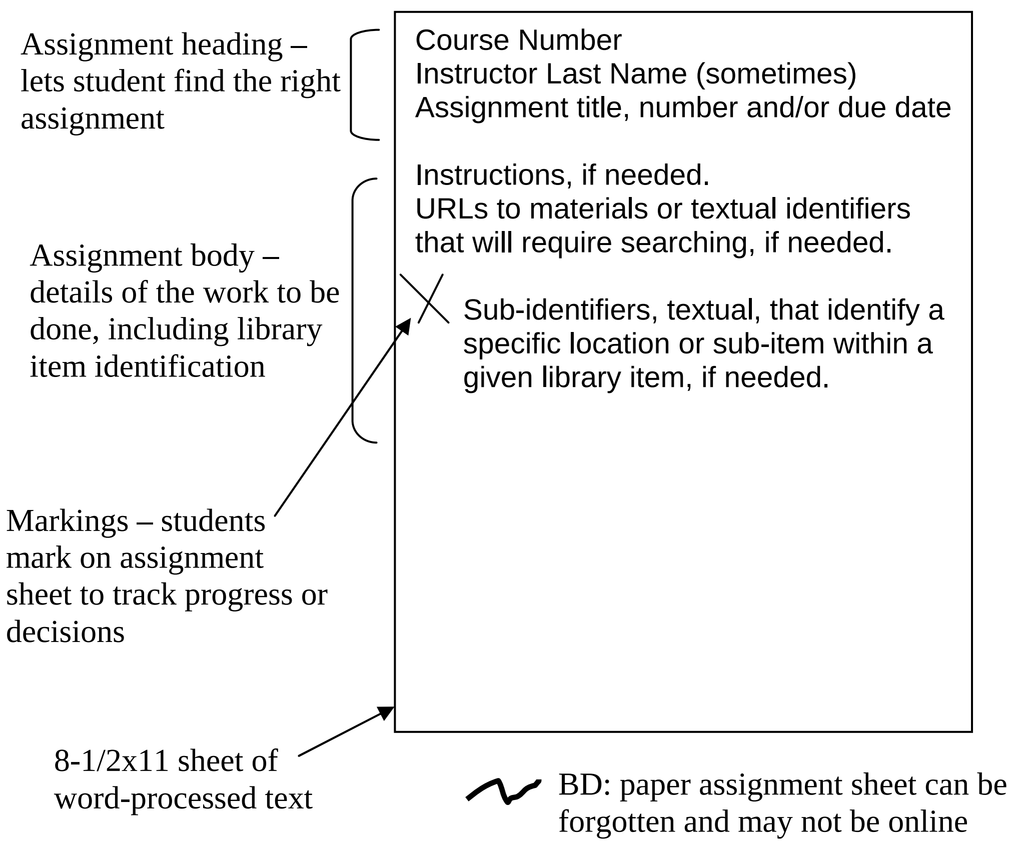


Figure 23. Consolidated artifact model.

Artifact Model: Critique

Designers in the scenario might wish to address the breakdown by trying to move instructors away from paper assignment sheets. But they could also note that they need to find a way to do this that will still allow students to annotate the assignment sheet as they work through it. The designers might also wish to make it easy to refer simply and unambiguously to library materials on paper or to index precisely into a item. Using artifact models, designers could compare assignment sheets across courses, disciplines, or institutions.

As mentioned above, one limitation of artifact models is that there is no standardized way to represent optionality. In addition to content optionality, there is also the problem of layout variability. The consolidated artifact model might wrongly imply that elements on assignment sheets always follow the same sequence. Yet it is difficult to show the variability clearly. Using Figure 5 as the basis for designing an online assignment tool might frustrate many professors who are used to organizing their assignments differently.

Another issue with artifact models is that, as with the flow model (which represents artifacts as information flow between roles), it becomes difficult to know or show how learning happens with artifacts. To illustrate this problem, a consolidated artifact model for student notes is given in Figure 24, showing the student mainly copying the instructor's slides and summarizing the lecture content. But what is the relationship between the artifact and student learning? Which things does a given student write down or summarize? Which omit? How did listening to the music and/or seeing the score during the class affect what was written down by a student? Although researchers could certainly ask such questions, such reconstructing of dozens of snap judgments may not be very accurate.

A final question about the artifact model is whether it is more meaningful to have a somewhat generalized model or to simply have the original artifact. If the objective is to compare, for example, the notes students take in music literature courses, art history courses, and film studies courses, is it easier to compare patterns of note taking and use by working with these content-free models? Or would it be a more fruitful analytical experience to compare the original artifacts? Perhaps having a binder of annotated student notes examples would be more helpful than trying to abstract or consolidate these items.

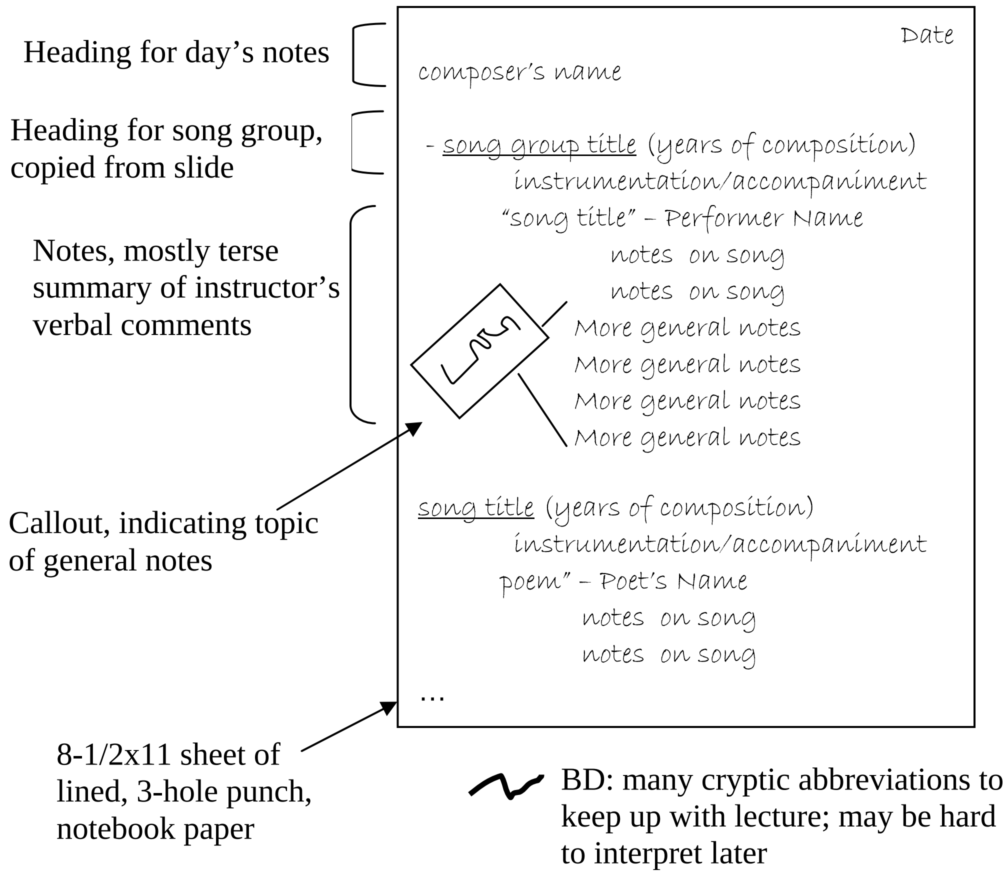


Figure 24. Student's notes artifact model.

Physical Model: Analysis and Example

Physical models show settings—and the relevant objects within those settings—where work occurs, as well as how those settings are structured and used (see analysis in Table 13). Fundamental to the physical model is the "place" (e.g., a study carrel at the library, the library itself, or a computer display). Most work occurs in multiple, nested places, and multiple levels will need to be represented in models. A model shows the organization of the place and how the place is used to accomplish the work, including tools, placement, and function of artifacts. For example, a workplace model of a library study carrel might show the layout of the student's materials on the desktop and shelf, the location of the various pieces of the computer system, and any other items. A separate physical model might show the layout of windows on a computer monitor. As with artifact models, annotations indicate usage and breakdowns.

Figure 25 shows a consolidated physical model representing the computer screen in a music library study carrel. Creating a physical model of the computer screen window layout is not specifically suggested in the CD book, but it seems to fit with the spirit of a physical model. Given that the focus of the scenario is system design that will affect multiple software tools, the location, use, and movement between those tools on the computer screen seems crucial to capture. The arrows in the model show how the user has to move between the applications and the task bar to keep switching between browser, word processor, and Variations2.

Table 13
Physical Model Analysis

Attribute	Representation	Examples
Place—location where work occurs. Could be large or small, e.g., site or workspace.	Varies, depending on the object.	a study carrel at the library, the library itself, a computer display
Structure—how the place is organized.	Layout, size, proximity of drawn objects.	layout of windows on a computer monitor
Tools—anything that is a part of the physical environment and impacts the work.	A simplified representation of the tool—often just a box—with an identifying label.	the computer monitor, a keyboard
Artifacts—anything created by the people doing the work, in the course of the work or to accomplish the work.	A simplified representation of the tool—often just a box—with an identifying label.	an assignment sheet
Usage—how the place is used in the course of accomplishing work.	Textual comments or callouts, pointing to the relevant location, or arrows showing movement.	"two windows placed next to each other for easy comparison of data"
Breakdown—a failure of the place to adequately support the work.	A red lightening bolt, labeled with a description of the problem.	"Headphone jacks often don't work."

There are no particular differences between the consolidated physical model and the individual one, other than the need for the consolidated model to represent variation and optionality. As with artifact models, individual physical models could be drawings but may also be annotated photographs or screen dumps.

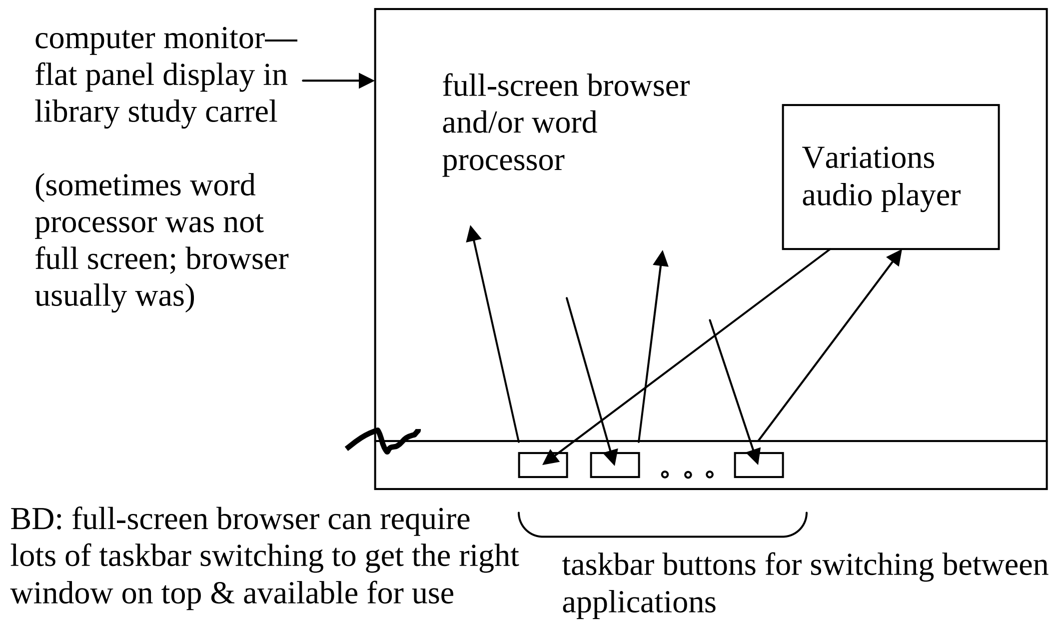


Figure 25. Consolidated physical model.

Physical Model: Critique

The designers in the scenario would likely pay attention to the window management problem. Will new software simply add more windows to organize and switch between? Or can some windows be combined for easier window management?

As with the artifact model, the physical model can run into limitations for expressing optionality and variation. Window management can be cumbersome. Students worked with one or more audio players, a web browser for searching the catalog and finding other information, and a word processor for typing up one’s notes or assignment. Students had idiosyncratic ways of arranging windows and switching or copying among them, as well as various methods of managing navigation within the audio recording. Possibly this variation could be expressed by creating a physical model of just the audio player and annotating it with the different navigation strategies.

Physical models may give some idea of the overhead involved in learning, but they do not convey much about the learning itself.

The physical model represents something much more dynamic than the artifact model. For example, students generally take notes fairly linearly and then the notes remain largely unchanged except when students may return to highlight or further annotate them in preparation for an examination. But the physical display hosts a constantly changing number of windows, which can typically be resized, minimized, moved, and scrolled. A possible way to form a more comprehensive picture of what is happening on the screen would be to combine successive physical models with a detailed sequence model.

General Critique

The work models taken together provide rich insight into the work practice the scenario design project hopes to improve. Each type of model provokes numerous design ideas, every breakdown is an opportunity for improvement, and using five different model types provides five different perspectives on a unitary activity. These multiple perspectives increase the likelihood that a product designed using this approach will provide a more holistic improvement to work practice. Unlike hierarchical task analysis, the CD model-based approach describes more of the significant contexts—organizational, motivational, physical, and cultural—within which work occurs and which all influence product usefulness.

The limitations of the models identified in the foregoing critiques can be summarized as follows.

Oversimplification. The modeling constructs generally do not provide a documented way to represent optionality and variation. Particularly in the consolidated models, this is a problem because there is no way to distinguish between things that are always a certain way and things that are sometimes a certain way. In sequence models, consolidated or not, the problem is compounded by the addition of randomness (as opposed to a specified order) and parallelism. A second area of oversimplification is the lack of clarity on the hierarchy of intents and knowing how to pick the right level of abstraction in the motivational hierarchy to represent with which modeling constructs.

Difficulty of representing classroom-based activity. Flow models may not be able to usefully represent highly interactive classroom-based learning activities with a roomful of students and multiple interactive technologies. Sequence models focus on one person's activity with the other people's intentions and actions as incidental; there is no way to unify the multi-role activity in a sequence model.

Difficulty in representing learning. The process of learning by listening to a lecture, participating in a classroom discussion, reading an article, listening to a piece of music, or reviewing one's notes might all be natural activities in studying, but there are not obvious ways to represent these activities with the CD models, which are based on observed behavior and the explanations of observed behavior. Possibly this is not an issue. It could be that any activity or action for which one would design something has an observable action, but that the things that go on internally without observable actions are not supportable by design interventions. This position is uncompelling, as it would rule out the value of many forms of information and message design, whether instructional or otherwise. It certainly seems that designing technology support for learning would benefit from some explanation of how external events and forms influence a person's learning in a given context. But CI and the models that express and organize its findings may not be the best way to derive these explanations, even for the purposes of technology design.

The identity-trajectory characteristic of learning also does not find representation in the CD work models. The culture model is static, yet technology designers may need to know where learners are in their progress from the periphery to the center of a community of practice as they work to support community-appropriate transitions from newcomer to old-timer (Lave & Wenger, 1991).

Although it is possible to find fault with any of the models, the question remains whether they are nonetheless good enough, or the best presently available. They may be. Making the models more expressive by adding more constructs also makes them more complex to construct. They are already complex to construct—possibly too complex to ever move into general use. The research in chapter 5 will explore this topic further. The models are not a precise, exhaustive record of observed activity but a kind of "quick and dirty" set of snapshots to help speed a design process that might otherwise ignore user needs or founder for lack of a shared understanding of the target customer. If the models have proven generally useful in technology design, then it is possible they will likewise prove generally useful in the design of learning technologies, perhaps supplemented with other models or constructs that more fully represent learning activity.

User-Centered Values in Educational Contexts

An interesting issue raised by this analysis is the potential conflict between the values of user-centered design and design in the service of improved learning outcomes. For example, the flow diagram assumes everyone is doing their “job”, that there is a money-based ecology and people collaborate to get work done. Work flow “defines how work is broken up across people and how people coordinate to ensure the whole job gets done” (Beyer & Holtzblatt, 1998, p. 90). In learning, the motivations may be less clear, and there are examples of collusion: “you help me get my degree and I won’t distract you from your research.” Some of this complex web of interacting motivations can be shown in the culture model. The notion of breakdowns is a valuable counterbalance.

Even so, practitioners may choose to adopt different positions on the continuum running between a service perspective and a transformative perspective. HCI traditionally has more of a service perspective—make the system more efficient and effective. In learning, if instructors push unproductive work at students to give them something to do, and students complete it merely to get the grade or degree, there is a breakdown or dysfunction in the learning environment. Should designers build systems that simply make that dysfunction more efficient and effective? Should learning technologies assume students are all adopting a deep rather than surface learning strategy (Entwistle, 2000), even when the latter is what a student may want in a given context? The transformative perspective asks deeper questions about what is supposed to be happening in a context and whether it actually is. While CD can be used to uncover the need for transformation and support the design of transformation, it is, by itself no guarantee and provides no framework for answering such values-laden questions.

Further Work

The fundamental question needing examination is whether CD models are even generally useful and are therefore used by those who have learned the CD process. Chapter 5 investigates use of the models along with the use of the rest of the CD process.

If the models are generally useful then the next question would seem to be how in particular they might become useful in the design of learning technologies. Without this adaptation, there is a danger that the learning technologies designed with CD will focus on the kinds of activity they most naturally represent rather than on the activity that may be most important to support for learners. To make progress on this question it would first be helpful to explore other representations of learning activity to see whether the aspects missing in the CD models are present in other representations. In addition, theory-based investigations of CD models could be helpful in examining their comprehensiveness (e.g., by comparing the work models to the activity theory model) as well as comparing the constructs they express to the constructs of interest to particular learning theories. Finally, if the models are useful then the community of designers who use them should find some way to publish and compare their models. Complex, detailed models do not fit well on the page of a standard publication nor within the page limits of many publication venues.

If the models do not prove generally useful, then other perhaps simpler representational methods such as personas could be examined in the context of learning activities as well as in the context of learning technology design projects.

5. SURVEY OF AND INTERVIEWS WITH CONTEXTUAL DESIGN PRACTITIONERS

Introduction

If Contextual Design is to be further considered as a means of aiding the design of educational technologies, it should first be asked what the experience with CD has been among its users generally. Although there have been a few case studies, comparison studies, and surveys that address CD at some level (see chapter 1 for a summary of these studies), no study has yet examined the question of how people who have learned CD make use of it or what attitudes they hold toward its utility. This chapter revisits the research goals from chapter 1 in light of the intervening chapters and summarizes the point of departure for this chapter. The chapter then describes the methods for this new study, and presents results of a multi-method inquiry. The results lead to an updated view of CD in practice.

Research Goals Revisited

As stated in chapter 1, the primary goal of this study is to investigate CD by comparing it with other methods and by examining how it is used by those who have learned it. A secondary but also important goal is to begin the process of considering how CD might be of use to practitioners of ISD. This section reviews the previous chapters, identifying issues raised that inform the study in this chapter.

Chapter 1 reviewed studies of CD and also presented my own experiences. It is noteworthy that in none of the case studies of CD were all six steps used. This fact, along with the eventual appearance of the second CD book abbreviating the CD process, suggests that certain steps of CD may be seen as more useful or essential than others. If this is true, a question arises whether some steps are universally seen as more essential, or whether the perceived utility of different steps merely depends upon differences between projects. The “lightning fast” version of rapid CD (Holtzblatt et al., 2005, pp. 37–38), which is the lightest-weight adaptation the authors propose, includes CI, listing of work notes during data interpretation, affinitization of those notes, and then some kind of redesign or design idea generation session based on the affinity diagram. In fact, CI and affinity diagramming are the only two techniques of CD present in each of the six single-case studies reviewed in chapter 1. Whether this minimal CD process is the one preferred in practice remains to be discovered.

Chapter 2 used a case study to explore how CD might be used in the design of an educational technology, a digital music library with pedagogical tools. In this case, CD proved to be efficient despite the fact that CD, like ISD, is sometimes accused of being slow and cumbersome. However, because this case study was a class project with few participants, the perceived efficiency of CD and the question of whether such a detailed process becomes an end in itself are issues still needing further exploration. Another question about CD raised in this case study concerns the level of expert guidance required for successful execution of the process. Finally, the ability of CD to provide a common language for communication between instructional designers and technology designers is considered a possibility. Although the present study does not examine this question directly, it will examine the extent to which people who have learned about or used CD believe its vocabulary and representations are successful in aiding interdisciplinary cooperation on design projects.

Chapter 3 used a second case study to explore how CD might be used along with design as it owes to traditions of product design, communications, art, and architecture, embodied in the PRInCiPleS framework. No inherent conflicts were found between the two approaches, but there was a notable difference in the level of specificity. This raises the question of whether designers prefer to be guided by higher level frameworks such as PRInCiPleS and choose to be eclectic about which techniques are used to build the design argument, or whether designers prefer to rely on more minutely prescriptive processes such as CD. If the former is preferred, there is the further question of what role learning CD plays: whether a useful one or not, and if it is useful, how so.

Chapter 4 presented an analysis of the CD models in terms of what they express and the adequacy of that expressiveness for the activity of learning. The models, although generally helpful for expressing the “office work” activities in an educational environment, were found lacking in their ability to express the complexity of interaction in a classroom environment, the interaction of a learner with learning materials in individual study, and the identity trajectory that occurs as learners move toward the center of a community of practice over time. For a survey of CD practice, this raises the question of the extent to which people have adapted the work models and why, particularly if those adaptations were made to address shortcomings in the expressiveness of the models. A related question is whether adding further expressiveness to an already complex modeling language is feasible. A further issue raised in chapter 4 was a potential conflict between supporting the objectives of the larger organization versus supporting the possibly divergent objectives of the individual roles, such as supporting deep or surface learning strategies. Thus a question arises whether CD projects have encountered such conflicts and the role, if any, CD played in exposing or resolving those conflicts.

Point of Departure

Based on the research and my experience described in the previous chapters, this section offers a summary statement of my current understanding of how CD is used and characterized by its practitioners. This statement fills the role of an initial indication of the preliminary understanding—the lens or the biases, in effect—that have shaped the design of the research in this chapter. As such, the statement also provides a means of gauging what is learned through this research, as the chapter will close with an update of this preliminary understanding.

Preliminary Summary Statement

> CD encapsulates much that people consider valuable in a user-centered design process. It is an externalization, through detailed steps and explicit deliverables, of an idealized design process, optimized for cross-functional teams developing computer-based solutions for professional "office work" environments. As an externalized, explicit process, it appeals to people who are relatively inexperienced at user-centered design and design generally. For the same reason, it is also pedagogically attractive. Thus the CD process may be metaphorically described as training wheels for designers.
>
> Because of the complexity of CD, access to an expert in CD is probably a necessary precondition to extensive use. The parts of CD most likely to be used are CI and affinity diagramming; work modeling, storyboarding, and paper prototyping are less likely to be used; user environment designs are rarely used.

> Even those CD practitioners who report a high level of knowledge of CD do not usually make full use of the process even if they value the entire process. They find that certain steps are better addressed through other approaches. They find that if they do the process alone it is more attractive to use internal processes rather than to create all the external representations. Some of the value they derive from CD is the sense of what matters—the principles of data, team, and design thinking outlined in chapter 1. As these principles can be embodied in techniques other than those of CD, CD serves as a carrier for these values, but it is not necessarily perceived as the best implementation of those values.
>
> The further a design project is from the design center of CD, the less likely CD is to be used. Thus if a project is not directed at office work or is not staffed by a cross-functional team housed in a technology organization, CD is less likely to be used.

Method

This study uses two methods to investigate the usage and characterization of CD by those who have knowledge of it. The first method is a broad survey; the second is in-depth interviews. The foregoing summary statement served as the basis for both modes of questioning, although the interview questions initially developed were revised after analysis of the survey results, and were progressively revised during the interviews (see interview method section below).

Survey

To provide a broad overview of the current usage of CD, a web-based survey was conducted. Beyond providing the broad overview of CD usage, this survey had the secondary purpose of providing contact information and screening data for the interviews.

Instrument. The web-based survey (Appendix A) was intentionally kept brief (approximately 5 minutes) with the goal of increasing the participation rate. The survey gathered data on three main areas.

1. Respondent's knowledge of CD—perceived level, how learned, experience with the various parts

2. Respondent's use of CD on a specific project—which parts used, how adapted, whence expertise for process leadership came

3. Respondent's attitude toward CD—advantages and disadvantages, intention to use in future

In addition, respondents were invited to provide their name and email address if they were willing to participate in a phone interview.

Recruitment. Respondents were recruited by email (see Appendix B), individually where possible but also by postings to relevant email lists. These lists included the following.

1. The ACM SIGCHI announcements list (chi-announcements@listserv.acm.org)
2. The ACM SIGCHI educator's list (chi-educators@listserv.acm.org)
3. The STC Usability SIG list (stcusesig_l@lists.stc.org)
4. UTEST, a private online community of professionals in usability and HCI (publication of email address not permitted)
5. British HCI Group News Service (bcs-hci@jiscmail.ac.uk)

In addition to explaining the purpose of the survey and providing a link to the URL, the recruitment email contained the study information as required by the Institutional Review Board of Indiana University. The recruitment email also invited recipients to forward the email invitation to others they know who have experience with CD.

Analysis. Discrete response items were tabulated. Scale items, in addition to tabulation, are represented by the median score. Free-response items were initially categorized using an open-coding approach; the benefits and limitations of free-response data were later placed in a hierarchy of categories, constructed using affinity diagramming to yield a rough organization of the data to facilitate presentation of the large amount of qualitative data.

Interviews

The interviews were designed to last approximately 20 minutes, and were conducted by phone.

Instrument and Protocol. The interviews were semi-structured in that a list of guiding questions was referenced during the interviews (see Appendix C) but additional questions or topics could be discussed as well. The interview questions covered the same areas as the survey but provided more detail and opportunity for clarification. In addition, several more complex questions about how participants characterized CD were asked, questions which required some explanation and hence would have been difficult to ask on the survey. Participants were asked to describe any conflicts that arose during their representative project between satisfying user needs and addressing organizational objectives and about CD's role in exposing or resolving these conflicts. Beliefs about the fit of CD with different disciplinary backgrounds or personalities were explored. Participants were asked to compare CD to other approaches based on the resource requirements and marketability of the process to clients and management. Reaction to the "CD as training wheels" metaphor was gauged and alternative metaphors solicited.

The interview questioning was progressively adapted: themes or issues emerging from earlier interviews were explored in greater depth in subsequent interviews with other people to arrive at more compelling interpretations. The initial questions in Appendix C were revised after analysis of survey results. Thus, although the interview had a semi-structured starting point, the interviews were ethnographic in approach, where the goal was to evolve an interpretation of how practitioners explain their use and understanding of CD.

Interviews were recorded but not transcribed. Recordings were reviewed to fill in gaps in the note taking as needed and to capture illustrative quotations.

Recruitment and Selection. Recruitment for interviews was done by means of the survey: survey respondents were invited to supply their names and email addresses if they were willing to participate in a 20-minute phone interview. Selected volunteers were emailed (Appendix D) to arrange an interview time.

The goal of interviewee selection was to enable exploration of a potentially broad range of people and contexts of use of CD. Interviewees were selected to provide a range among the following variables: country (slight bias toward non-U.S. to counterbalance my own U.S.-based experiences and the U.S.-based development of CD), employment sector (bias toward industry and consulting as opposed to academia because of focusing on practitioners), and level of both experience with CD and amount of detail in survey comments (slight bias toward higher, to benefit from possibly deeper reflective practice). In addition, interviewees were selected to provide a broad range of work contexts. In cases where, for example, 3 survey respondents worked for the same firm, one at most was chosen for interviewing. A desired balance of gender among the respondents also influenced selection.

Analysis. Analysis was continuous, beginning with the analysis of the survey results and continuing through the interviews. An ethnographic field notes approach was used (Emerson, Fretz, & Shaw, 1995). Initial notes were followed by initial “memos” about each interview; integrative memos were developed from reflection on individual interviews. Once the interviews were completed, data from interviews were organized into a large summary table based on the questions in the interviews. The integrative memos and the summary table formed the basis of the interview results report included in this chapter.

Survey Results

Survey invitations yielded 106 responses in January, 2008. Of those, 56 supplied email addresses, qualifying them for possible interviews.

Reported Knowledge Level and Sources of Learning

Those responding tended toward reporting more rather than less knowledge of CD. To the question “How much do you know about Contextual Design?”, 34 responded “A lot,” 62 responded “Some,” and 10 responded “A little.” To the question, “How did you learn about Contextual Design (check any that apply)?”, respondents reported learning primarily (65%, N = 106) from reading the CD book (Beyer & Holtzblatt, 1998) and the same percentage from unspecified “reading other articles and book chapters.” The full tabulation of responses is given in Figure 26. The answers of 29 respondents appear to indicate being self-taught, without any mention of having received formal training, coaching, or informal apprenticeship. Of the 35 “other—please specify” reported sources of learning, the dominant category was learning by doing (22), with phrases such as “on the job,” “doing it,” or “practice” mentioned multiple times.

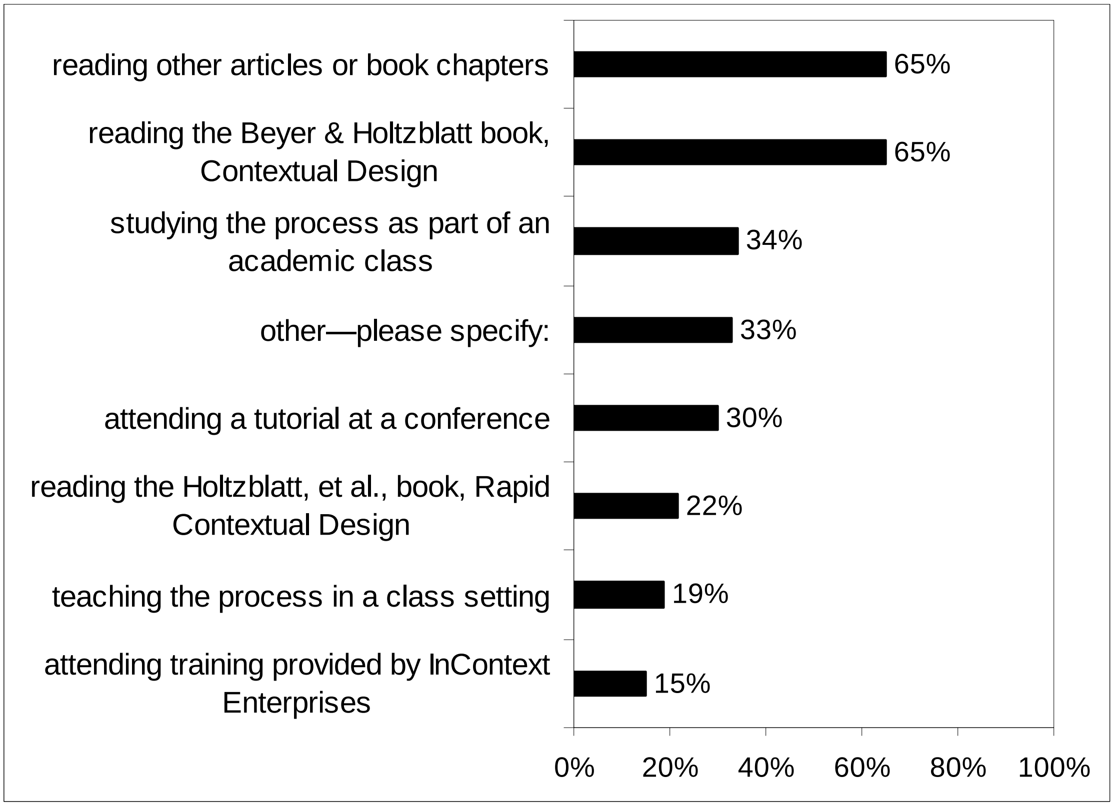


Figure 26. Reported sources of CD learning, in answer to the question, “How did you learn about Contextual Design (check any that apply)?” N = 106.

Reported Experience with Techniques

The survey asked twice about usage of CD techniques, (a) whether the respondent had used a technique in some form, and (b) on a work-related project considered the most recent use of CD, whether they had used a given technique. Of the 106 respondents, 83 (78%) reported on a most recent CD project. Consolidating the results of the techniques into the six defined steps of CD and counting usage (see Figure 27) indicates that CI has the highest reported use, both in reports of any use (84% of 106 respondents) as well as use on the most recent CD project (92% of 83 projects). Work modeling is second (81% of 106 respondents, 80% of 83 projects). Use of the other steps was reported by the majority of respondents and on the majority of projects, except for user environment design (26% of 106 respondents, 19% of 83 projects).

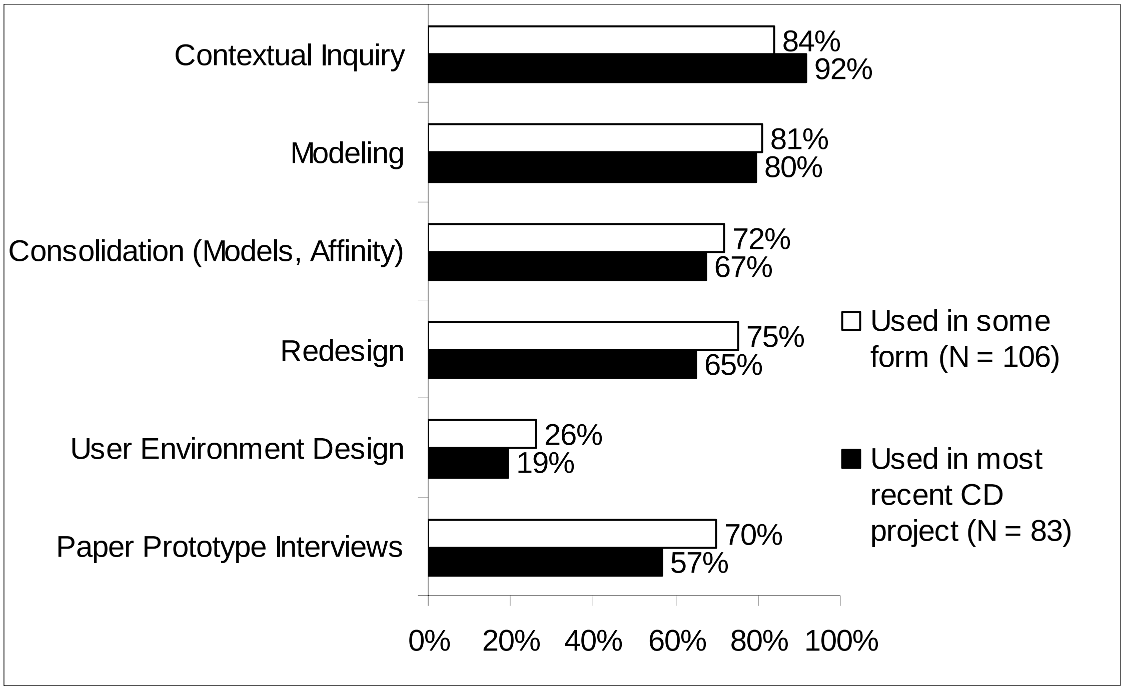


Figure 27. Reported usage of CD steps overall and on most recent CD project.

Separating the reports of modeling use (Fig. 28) shows the most reported usage for flow (67% overall, 58% on recent projects) and sequence models (61%, 49%), with fewer reports of other model types or model consolidation.

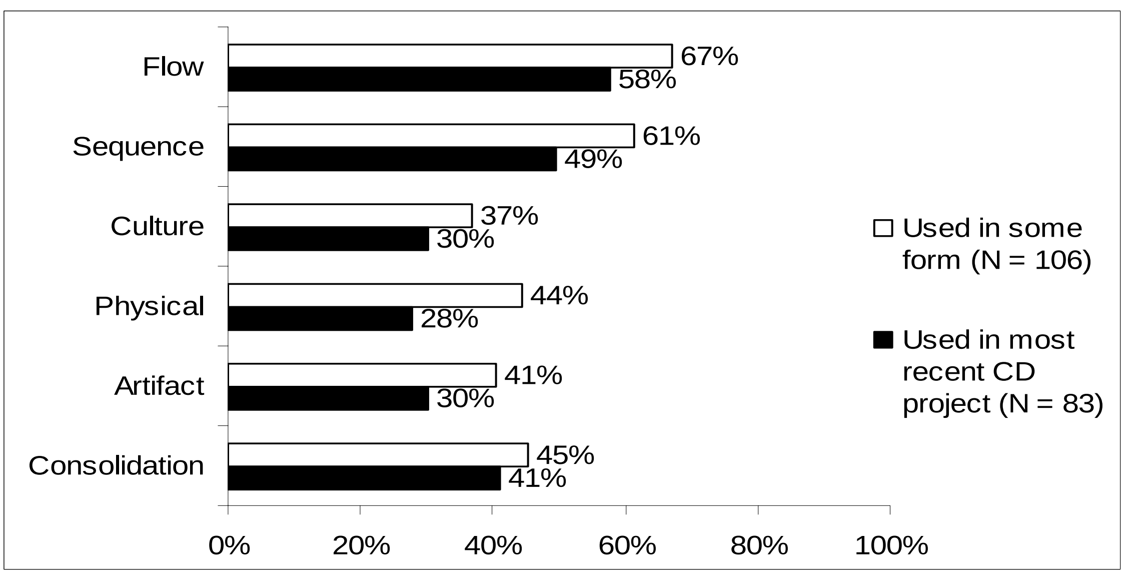


Figure 28. Reported use of model types and model consolidation overall and on most recent project.

Individual techniques used on the most recent work-related CD projects are shown in Figure 29. Separating out the techniques in this way shows the prominent use of CI (92% of 83 projects). Use of flow models, affinity diagramming, and paper prototype interviews was reported on a majority of projects. Use of the other techniques was less often reported.

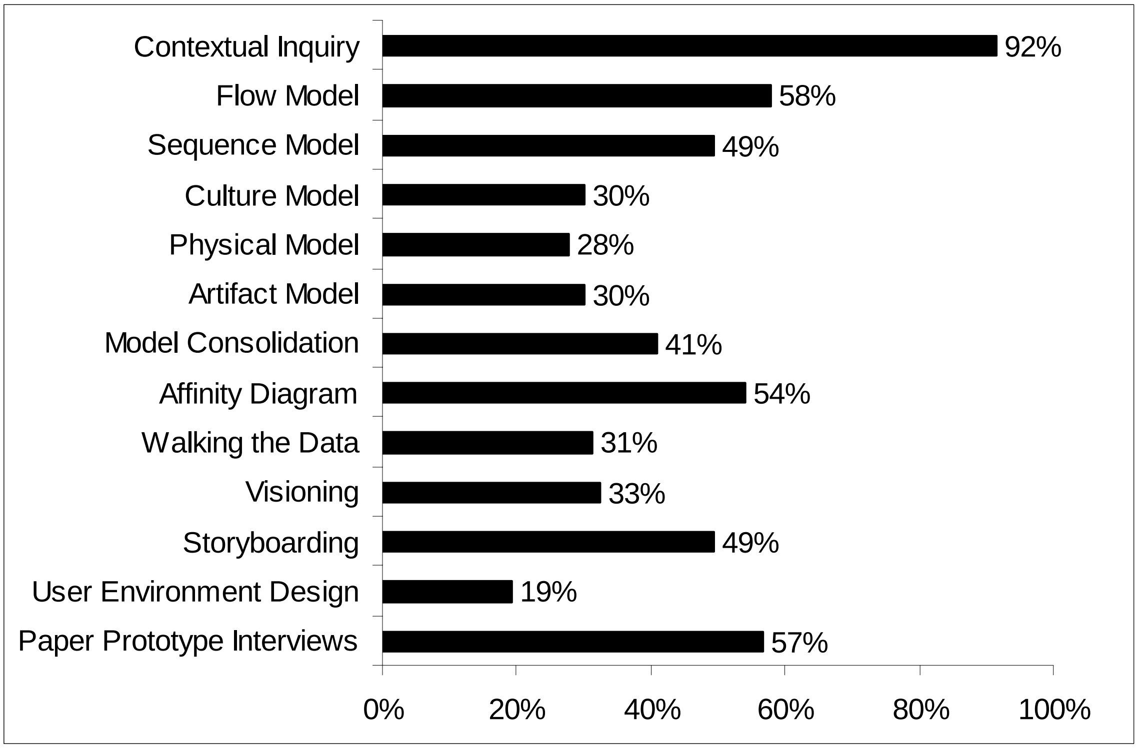


Figure 29. Reported usage of CD techniques on most recent CD project ($N = 83$).

<u>Ratings of Success, Efficiency, Adaptation and Likelihood of Future Use</u>

Three scale items provided an opportunity for respondents to rate the success and efficiency of CD on their most recent work-related project, and to indicate how closely the CD techniques were followed on the project. Overall, median responses were positive for both the success and efficiency questions (see Table 14), although respondents not providing their email addresses were slightly less positive on both measures than were respondents providing email addresses. The median responses also indicated at least moderate departure from documented CD techniques, with those not supplying email addresses reporting that they followed CD more loosely than those who supplied email addresses.

A fourth scale item, also shown in Table 14, gauged reported probability of using CD in the future. Those supplying email addresses reported a higher likelihood of anticipated future use than did those not supplying email addresses.

Table 14
Scale Item Median Responses Overall (N = 106), for Those Supplying Email Addresses (N = 56), and for Those Not Supplying Email Addresses (N = 50)

Scale item	Median		
	Overall	Email	No email
How successful do you feel Contextual Design was for this project? (1 = successful, 7 = unsuccessful)	2	2	3
How efficient do you feel Contextual Design was for this project? (1 = efficient, 7 = inefficient)	2	2	3
For the parts of Contextual Design you used, how closely did you follow the CD process? (1 = closely, 7 = loosely)	3	3	4
How likely are you to use Contextual Design in the future? (1 = likely, 7 = unlikely)	2	1	3

Benefits and Limitations

Survey respondents were given free-response items to describe both the perceived benefits and perceived limitations of CD. Out of 106 total respondents, 88 described one or more benefits of CD and 86 described one or more limitations. This section provides two views of those responses. First, at a high level, the results of the affinity analysis provide an overview of the themes that emerged from the detailed comments. This thematic overview is important because it combines both benefits and limitations into a hierarchy of thematic categories, revealing areas of disagreement and emphasis. Second, at a more detailed level, the rank-ordered benefits and limitations are described, providing a sense of the strengths and weaknesses of CD that were most often mentioned.

The five top-level thematic categories are as follows: (a) resource requirements, (b) CI data, (c) CD as a design process, (d) organizational fit, and (e) applicability. The number of responses represented by categories and subcategories are given in parentheses.

Resource requirements (84). Resource requirements were grouped into two subcategories, time (73) and expertise (11). Comments in this category were uniformly expressed as limitations, with the exception of two respondents who suggested CD could avoid wasting time, prevent rework, and provide a focus on what is essential. The time-related limitations of CD expressed by respondents were primarily with respect to the overall time- and resource-intensiveness of the CD process (42, the largest overall limitation mentioned), the difficulty of identifying and arranging contextual inquiries (14), and the difficulty of selling such a time- and resource-intensive process to management, clients, and customers (10). The expertise-related limitations consolidated into a single topic expressing the high level of training required and the relative scarcity of such personnel.

Contextual inquiry data (76). This category contained a mix of benefits and limitations beneath three subcategories, quality (55), insights (12), and sources of bias (9). The quality of CI data was primarily expressed in comments about the data being "real," "actual," "solid," and "first-hand" (52, the largest overall benefit mentioned). CI data was also seen as providing valuable insights, "a ha" moments, and "crucial cultural insights" (7), but concern was also expressed that the focus on existing work practice could stifle innovation (4). Finally, respondents expressed disparate concerns about the various ways CI could result in a biased understanding of users, such as subjective interpretation, the impact of the observer on the work practice, or cross-cultural issues.

CD as a design process (71). This category contained a balanced mix of benefits and limitations beneath four subcategories: process formalization (37), interdisciplinary sense-making (24), and the fit with other methods (5), in particular with usability engineering (5). The formalization and systematization of CD was seen as both a benefit and limitation. On the one hand, the closed-loop, fully specified comprehensiveness of CD was seen as a benefit (12), but others expressed concern that these same qualities could lead to excessively rigid use (7). Uniformly positive statements support the ability of CD to make sense of a large amount of data from multiple perspectives and communicate the results of the analysis to people from varying disciplines (17). The ability of CD to integrate with other methods was seen as positive (2) yet also as a limitation because other methods were required (3). An expressed limitation of CD was its lack of integration with usability engineering, whether in setting usability goals and metrics (2), or the ability to extract usability problems (2).

Organizational Fit (26). Comments put in this category were also a balanced mix of benefits and limitations, in three subcategories: shared understanding (18), perceived process validity and value (5), and business awareness (3). All but two of the comments in the shared understanding subcategory were positive, and the common topic was the ability of CD to create a shared vision of the user's needs among diverse stakeholders (11). Respondents pointed out that some stakeholders may not understand the design process, the need for it, or why the results are valid (5), and others indicated that CD does not adequately address such existing business processes as competitive analysis or business prioritization, nor does it take advantage of preexisting customer knowledge in the organization (3).

Applicability (12). Respondents offered a diverse set of ideas about situations where CD was more or less applicable. Comments noted the value of CD to requirements identification (3) and the broad range of products and services to which it applies (2). But respondents also questioned how well CD was adapted to the development of websites, complex organizational environments, learning design, and highly complex systems (4). There was little consensus in this category. For example, CD was mentioned as being both applicable and not applicable to the design of learning systems.

Rank-Ordered Benefits. The topics mentioned five or more times in the descriptions of CD benefits were as follows: the resulting deep, true, real understanding of users, tasks, and contexts (52); the comprehensive and coherent presentation of data (17); CD as a systematic, closed-loop design method (12); the resulting shared understanding on the team and among stakeholders (11); the flexibility and adaptability of CD (8); and the insights resulting from the process (7).

Rank-Ordered Limitations. The topics mentioned five or more times in the descriptions of CD limitations were as follows: the time and resource intensiveness (42); the difficulty of identifying users and arranging inquiry sessions (14); the required high level of expertise (11); the difficulty of selling the process to management, clients, customers (10); and the level of formalization and rigidity (7).

Even among these frequently mentioned topics, there is disagreement about whether CD is flexible and adaptable, or is instead too rigid. Roughly the same number of respondents adhere to each side of the disagreement.

Interview Results

Participants

Of the 56 survey respondents supplying email addresses, 25 were identified as non-US, based on the email address domain or information gathered from internet searching for the respondent's name. Of the 20 selected following the goals and criteria outlined in the interview method section above, 15 responded and agreed to be interviewed. Three additional survey respondents were selected who fit the selection goals and criteria, and 2 of those were also interviewed, yielding a total of 17 interviews, which occurred between February 12 and 29, 2008. During an interview, one of the participants was determined not to have heard of CD even though he had filled out the survey and regularly does ethnographic research, so data from only 16 interviews are included in this results section. Participants all seemed very interested in providing answers to questions, offering opinions and information, and many asked about the goals of the research, expressing interest in reading the results. This high level of interest led to the interviews averaging more than 40 minutes in length rather than the initially anticipated 20-minute length.

Of the 16 participants, 9 were U.S.-based; the other 7 were based in the United Kingdom (3), India (2), and Finland (2). The employment sector was distributed as follows: 6 worked in industry or governmental organizations and described themselves as practitioners, researchers, or internal consultants; 6 were external consultants, 3 being independent and 3 working for consulting firms; 4 were academics, 2 of whom were engaged in research projects for their doctoral work; and 2 were faculty who undertook sponsored research. The relatively higher representation of academics in the non-U.S. selection pool required that some academics be chosen to satisfy other selection criteria. Participants were split between indicating a high level of knowledge of CD (8 marked "a lot") and a moderate level of knowledge (8 marked "some"). Only two were self-taught, but these two, on the survey, rated their use of CD on their most recent project as successful (2 on the scale where 1 = successful and 7 = unsuccessful). On average, participants had used 9 of 13 techniques listed in the survey "in some form" and had used three of the five model types. As mentioned in the survey results, the interview selection pool was biased toward people who indicated a high likelihood of using CD in the future, so participants were selected in such a way as to bias the likelihood of future use lower than the average for the selection pool. Interview participants' survey comments tended to be more extensive than the comments of those not selected. No 2 participants worked for the same employer or on the same project. An even split in gender was achieved (8 male, 8 female).

Use of CD on Most Recent Project

Respondents were asked to describe a recent or representative project that made use of CD. Twelve of the 16 were office work of some kind, across a wide range of industries and applications (e.g., geophysics, content management systems, investments, retail billing, pharmacy). The other projects were studies of personal hygiene habits (tooth brushing), live-action role playing games, and mobile-devices (2). All projects were conducted by teams of 5 or fewer; three projects were conducted alone, and four team projects were identifiable as multidisciplinary. In only one case do programmers appear to have been part of the team. Table 15 summarizes the usage of CD steps and techniques reported.

Table 15
Reported Usage of CD Steps on Representative Projects (N = 16)

Step	Reported usage count
Contextual inquiry	13 (2 others did laboratory-based observations, not contextual)
Modeling	5, mainly flow and sequence, with one doing all five types
Consolidation	2 consolidated models (skipped individual models); 8 did affinity diagramming
Redesign	3 did wall walks; 5 did visioning; 2 did storyboarding
User environment design	1
Paper prototype interviews	0 (some prototype evaluation, but not in context or not paper-based)

Contextual Inquiry. Thirteen of the projects reported using CI in some form; two reported doing laboratory-based observational studies instead, and one project did no observational studies. Those reporting CI also described numerous adaptations of the technique, some of which are adaptations suggested by Beyer and Holtzblatt depending on the interview situation (1998, pp. 73–76). For example, the participant conducting the personal hygiene (dental care) study described videotaping subjects and then reviewing the videotape with the subjects later in the day. Three mentioned making significant use of photographs (absent from the original CD book but recommended by Holtzblatt et al., 2005, p. 91). Two others described significant use of retrospective accounts in addition to or in place of observations of current work activities. Other reported adaptations went beyond what is suggested in the CD book. For example, 3 participants mentioned transcribing recordings of interviews (3), 1 of these commenting on how labor-intensive CI was as a technique, primarily because of the time it took to transcribe—even though transcription is not recommended as part of the CI technique. Three participants described using some form of structured or semi-structured interviewing as part of the CI. Five participants reported a more participatory approach, where those being observed were also asked to describe ideal experience or otherwise offer design ideas as part of the interview. In one case, a participant described having a panel of subjects respond to a summary of what had been learned during the CIs.

Modeling. Five participants reported using some kind of work modeling to capture the data from CIs. One reported creating all five models, and this was the only participant reporting both model creation and participation on a multidisciplinary team. Total reported model use was reported as follows: five reported using sequence (one of these was a combined flow/sequence model), three flow (including the combination), two culture, two physical, and one artifact. Most of the participants indicated they did not use individual work models but instead relied on notes and photographs or created individual work notes for later affinitization (see below) as a means of representing what was learned during the CIs. However, participants often mentioned using knowledge of the models as a framework for thinking about their data in both the collection and analysis phases, even when they did not construct actual models. For example, 1 participant described using all the model types as headings, which forced the team to look at their field notes from multiple perspectives. Another participant described extracting intents and role definitions from field data rather than building complete sequence and flow models.

Consolidation. Only 2 participants reported creating consolidated models as a means of representing work practice across multiple observations. Both were flow models. Both participants described creating these consolidated models directly, without having done flow models for the individual observations. One of these 2 was leading a multidisciplinary team; the other participant created the consolidated flow model working by herself. Other non-modeling consolidation techniques reported were distilling personas or scenarios (3) and pulling out themes or doing open-coding (2). More frequently mentioned was the use of affinity diagramming (8), although the process for creating the affinity diagram occasionally departed from the recommend approach of gathering a larger group of people together to complete the affinity diagram in no more than a day (Beyer & Holtzblatt, 1998, p. 162). One participant reported creating the affinity diagram entirely by herself; another reported a small team creating an affinity diagram over a period of many months.

Redesign. Five participants described some kind of visioning activity as part of a design (or work redesign) effort. Three mentioned "walking the wall"—inviting people to browse the affinity and other data to generate design ideas. Two participants reported creating storyboards based on the results of the visioning step. Another participant described a kind of reduced storyboard approach, where each storyboard consisted of three frames: a representation of the current situation, a description of the solution, and a representation of the future situation enabled by the solution. Some participants not reporting any or all of the CD redesign techniques instead described using other approaches, primarily working alone: extracting or listing requirements, sketching design ideas, building wireframes, or putting design ideas into a slide presentation.

User Environment Design. Only one person indicated use of the UED diagram. The list of alternate techniques just mentioned in the redesign section above seemed to substitute for the UED as well. One participant commented that the UED would never work in her environment because it was too nonstandard as a way of specifying system requirements.

Paper Prototype Interviews. The biggest divergence from the survey findings was the complete absence of reported paper prototype interview use by the interview participants. In some cases the participants reported that the projects ended before reaching this step, or an earlier step (see next section). In the three cases where prototype validation of some kind was mentioned, the technique described was either laboratory-based testing or was not paper-based; in one of the three cases, the project had not yet reached prototype validation, but laboratory-based testing was mentioned as the current plan.

Step Skipping and Project End Points. What the foregoing description of CD step usage fails to capture fully is the extent to which the objectives of a particular step were accomplished by other techniques, whether the step was skipped entirely, or whether the project ended before the step was reached. As shown in Table 16, the majority (11 of 16) completed or were prematurely terminated before reaching the stage at which user environment design or paper prototype interviews could be used. This finding in part derives from the role of the participants on their respective projects. Many of the participants were not responsible for anything beyond fairly high-level design ideas, a list of requirements, or a list of usability issues, or wireframes (see Table 3, projects 1, 6, 8, 13, 14, and 16). In other cases, the client or management chose not to complete the project, either because preliminary data indicated the project was not worth attempting (project 3), or because of funding or other commitment issues (projects 2, 3, 7, and 11).

Table 16

Reported CD Step Usage Summary by Project

#	CI	Mod	Con	ReD	UED	PPI	Notes
1						x	final deliverable: wireframes
2					x	x	client didn't follow through
3			x	x	x	x	models showed project not feasible
4					x	x	funding problem midway through
5					x	x	evaluation, not new design project
6					x	x	ended with "needs extraction"
7					x	x	client didn't follow through
8					x	x	ended with design ideas
9							CD informed; no techniques used
10							
11					x	x	client didn't follow through
12							
13				x	x	x	final deliverable: affinity & flow
14				x	x	x	wrote requirements
15							
16					x	x	ended with design ideas

Legend
CI – Contextual Inquiry
Mod – Modeling
Con – Consolidation
ReD – Redesign
UED – User Environment Design
PPI – Paper Prototype Interviews

	Used one or more CD techniques
	Substituted other techniques
	Skipped step
x	Project ended prior to this step

<u>Characterization of Contextual Design</u>

Participants characterized CD and their relation to it throughout the interviews, but several questions served to focus the topics of that characterization in order to address questions raised in earlier chapters.

Conflict exposure and resolution. Participants were asked whether the use of CD on their representative project (or in some cases other CD projects) had exposed any conflicts between user needs and the objectives of the sponsoring organization (client or management). Participants largely agreed that CD had exposed such conflicts, with 9 participants answering "yes" and 2 answering "no". The other participants either did not know or did not answer. On one project, the CIs and modeling revealed that the users of a planned content management system had such divergent workflows that moving to a single system was untenable. On several projects, the field work indicated that the need for technology was much less than the clients had hoped. One participant commented that in many cases, technology companies sponsored studies in the rural areas of India, hoping to find market opportunities for their products, but they instead found much larger needs for sustained development activity, which was beyond the scope of those companies' product and service offerings. Another participant commented that collecting user data in context ends up broadening the scope of the project and affecting people in other parts of the organization, which can cause the project to become "political." This politicizing effect was commented upon in detail by another participant.

> *But I think that it's a matter of power—it's power politics. A lot of people don't want to give up their role as the decider. … Actually having that data is kind of incendiary in a way! Because it takes all of the politics out of the whole discussion … and a lot of people don't like that. They want to continue with their corporate or internal power politicking exactly as they always have, and they don't want to change.*

When asked the second part of the question, whether CD had helped resolve those conflicts, participants largely indicated that it had not, with 1 answering "yes" and 7 answering "no." Although the data about user needs and their context could in theory help resolve the conflict between user needs and organizational objectives, participants commented that CD had no mechanism to bring about that resolution. Two participants who were external consultants suggested that as external consultants they were in a position to more easily address the political issues because "that's what they hire us for"—to provide an external perspective. One interview participant commented that there is a lot of resistance in the business world to being customer-focused. Another commented that the discussion resolving these conflicts "belongs in a bar" and that it has to involve management in some way.

Impact of CD on the Practitioner. Participants were asked how knowing CD had affected them as practitioners. This question received a range of responses, from "it's nothing new" to "it transformed how I do my work." Responses tended more toward the latter, with claims that learning CD had been "very valuable" or "fantastic," that it "works brilliantly," and that they could not think of another way to accomplish the same thing. Answers to this question were analyzed with open-coding, resulting in the following primary impact categories: CD as a framework for thinking, planning, analyzing (20 comments); having learned the value of context and work practice (9); having learned techniques for communicating about users and their work (9); and having learned techniques for interviewing and observing (8). One participant comment pulls together much of what other participants also said about the personal impact of CD.

> *One of the things I really liked about what Karen [Holtzblatt] and Hugh [Beyer] had done is pull from different kinds of disciplines and come up with a best in class collection of tools that helped you think about what mattered but also helped you do it, too. And I think as I've moved forward here, I still use a lot of those principles. I use some of the tools, but I rarely stop there—I use lots of other kinds of tools too.*

A Metaphor for CD. Related to the previous question was the question about an appropriate metaphor to characterize CD. My initial idea was to think of CD as training wheels, as a means of learning one's way as a practitioner, but something that could be largely dispensed with after the initial learning was complete. This metaphor did not receive full support from interview participants as the primary metaphor. No single metaphor fully captures how practitioners characterized CD, and the line of questioning evolved over the course of the interviews, so it is not possible to give accurate counts for the different conceptualizations. Four overlapping metaphors emerged, only one of which bears much resemblance to training wheels. The two most commonly supported concepts were CD as a guiding framework or checklist, and CD as a toolbox.

As a guiding framework or checklist, CD was seen as helping people remember what's important or see if they have left omitted anything when planning a project. The models in particular work this way, reminding practitioners of the different aspects of work practice to attend to. One participant summed up this metaphor as follows.

> *Maybe I myself conceptualize it more like a kind of a basis that you are aware of when you are planning work, so that you don't forget something that is important. So it's a kind of checklist kind of a thing, that once you plan for different stages in a project, you might think of the different stages of a contextual design process and you think [about] what you find important. If you're not aware of contextual design, then you might forget to do something that might be valuable.*

As a toolbox, CD is viewed as a collection of best-in-class techniques that can be chosen among and adapted to address the situation at hand. Most prominent among the tools in the toolbox are CI as a way of understanding work practice (the main wheel, one participant called it, not a training wheel) and the affinity diagram as a way of organizing field data. The “best in class” set of tools comment quoted in the previous section supports this notion.

The framework and toolbox metaphors can become mixed. One participant commented extensively on CD as a toolbox, but the toolbox contents for her were more concepts than techniques.

> *There’s a lot of things in there and a lot of questions to ask, and a lot of ways to look at it, that sort of become a toolbox that you can pull out later, right? So if you’re in another situation … you know to look for certain physical clues for physical modeling, or some cultural clues that you might not otherwise have known to pay attention to because now they’re in your toolbox, and yeah, you can put all those tools together and come up with a contextual design exercise and have great projects, but you can also take those pieces that are also part of your toolbox … you can take those pieces and understand things in a different way and come back to those concepts.*

Another characterization of CD, though not expressed as a metaphor, was a set of “underpinning principles” such as context, apprenticeship, understanding work practice, and seeing data. One person commented that going through a full CD project was like using a power tool because he was able to learn much more quickly than by reading about principles on his own. Another participant commented, “the principles are absolutely solid.”

Finally, 1 participant used the metaphor of religion: It can be taken too far, but if you keep the right parts when you grow older, it can work for you. This last metaphor is the one most like the training-wheels notion. Some other participants also mentioned the pedagogical value of such an explicit, end-to-end process. One participant commented that it is a good education to study CD if you have not studied other formal methods. Another, who now teaches designers, said that CD has had an impact on his design teaching because it gives things names, organizes things, and expresses much of what he wants to say. This statement supports both the first metaphor of CD as a guiding framework and also offered support for the pedagogical utility of CD. Another participant commented on learning CD as being like learning to drive a car.

> *It's like learning to drive the way that you have to do it for your test, and then coming back every now and then. Okay! Let's double-check. Am I doing everything I need to do right? Your hands definitely slip from ten and two, and you definitely adapt to what you're holding in your hands or what you need to do or anything like that.*

One aspect of the CD-as-religion metaphor bears further mention. Although practitioners uniformly seemed comfortable tailoring the process to their needs rather than following it as blind adherents, several comments about people associated with InContext Enterprises (the originators of CD) described a perceived over-zealousness for the method, being "unrealistic," religious about it, glossing over difficulties, or having a "this is the only way" attitude. Other comments presumed the existence of a CD orthodoxy, a correct way of doing things that was represented by the CD book or by InContext. If one judges only from reported behavior, this perceived attitude does not seem to cling to practitioners. One participant commented about this.

> *You have to read between the lines … they have written the book as a kind of a nice package of things that solves almost any problem, because that's the way they want to write the book. But that's the same thing about any other book or research paper that people write, so they want to emphasize the good side and put down the bad side. But this is fine because everyone works based on that kind of principle. They want to promote their own ideas. But of course if somebody wants to be an experienced practitioner in this field, he has to just understand that this is the way people express these things, and try to see what is left outside because it didn't fit into their framework.*

Cost of Doing CD. From the survey responses it was apparent that CD was seen as expensive, by clients, management, and practitioners themselves. What was less clear was whether CD itself is too costly, or whether any process yielding equivalent results is likewise expensive. In the interviews, all participants answering this question expressed agreement that any kind of field study approach to uncovering user needs and work practice is more resource-intensive than other approaches to design but that the results were not equivalent: the field studies yielded better results. Participants were divided on the question of whether CD as a field study approach was too expensive. Seven of 13 answered this part of the question commenting that doing CD “by the book” was too expensive, more expensive than quicker approaches producing equivalent results. These participants said that equivalent results can be achieved by selecting, adapting, and pulling in other techniques such as personas or usability testing. Three participants said that processes quicker than CD would not yield results of the same quality.

Marketability of CD. Closely related to the cost of CD is the difficulty of selling CD to clients or management, a problem identified by survey respondents as a major limitation of CD. In the interviews, the main reason given for this difficulty was that up-front fieldwork-based processes like CD are not as well known as laboratory-based testing (6 comments). One participant commented that CD lacks the “theatricality” of laboratory-based testing, lessening its appeal. Another pointed out that evaluation techniques have a defined progression from quick methods such as heuristic evaluation to more expensive techniques such as formal laboratory-based testing. Field study techniques, in addition to being less well known, do not have this same “sliding scale” of choices. Other reasons given for the difficulty of marketing CD were that it appears to be resource intensive (4), engineering arrogance or self-sufficiency gets in the way, with user-experience people being viewed as nice to have but not required (3), and the invasive, potentially disruptive nature of CIs (2).

Despite the difficulties of selling CD to clients and management, there were at least a few indications of improving ability to do so. Two participants commented that, because CD is a documented, known process with a book about it and a consulting firm that developed it, CD had some credibility with clients or strengthened a bid (2). Another participant pointed out that ethnographic approaches to design are getting more mention in the press recently.

Appeal of CD. One question raised by chapter 3 was whether CD is more appealing to certain kinds of people or to people from certain disciplinary backgrounds. In particular, would analytical people, or people from analytic disciplines who had not had design-school training be more attracted to a prescriptive, explicit process like CD while more creative people, or people with design-school training, might feel slowed down or boxed in by CD? No clear answer to this question was evident. Some respondents thought CD worked best for creatives, others that it worked better for analyticals, and yet others stated that it was not possible to generalize about such groups or had no opinion on the matter. Two commented that CD is intentionally multidisciplinary, requiring a variety of skills and backgrounds to be successful. There was more agreement around the issue of whether certain kinds of personalities should not conduct CIs. Participants noted that CIs were not likely to be effective if conducted by people who already have their minds made up, who do not listen, who are "conversationally uncomfortable," or who cannot put people at ease because they are too threatening or imposing.

Gaps in CD. Interview participants were not specifically asked what CD lacked or did not address well, but a number of similar comments were received on this topic nonetheless. The category most frequently mentioned was the problem of how CD fit with the larger organization (10 mentions). The problem of CD not fitting into a traditional requirements process or it being difficult to extract requirements from CD was mentioned by 3 participants. Other comments in this category were that CD is too much of a "deep dive" that does not provide immediate feedback to developers, that follow-through is problematic (supported by the number of projects on which clients were reported not to have followed through), and that CD ignores the value of preexisting organizational knowledge about users. The other major category of comment was that CD misses some important kinds of data (6 mentions), in particular quotations, stories, or personas, which all help user data "come alive" (3). One participant commented that CD provided no way to elicit users' ideas about ideal or emotional experience, echoing the findings from the Jääskö and Mattelmäki case study described in chapter 1 (2003).

Conclusion

This chapter began with a summary of questions raised about CD in chapters 1 through 4. These questions were followed by a preliminary summary statement, the point of departure for the research this chapter reports. This concluding section therefore returns to the questions raised in chapters 1 through 4 about how CD is used and characterized by its practitioners, and considers the extent to which those questions have received answers. Based on those outcomes, I update my summary statement, and finish with reflections on the limitations and achievement of the two studies in this chapter.

Questions from Earlier Chapters, Revisited

How many steps? The question from chapter 1 was whether the reduced version of CD common in the case studies (CIs and affinity diagramming) is the preferred process, with the other steps often being omitted. The survey data on most recent CD projects does not support this minimalist reduction. Although survey data do point to prominent use of CI, the same data also indicate work modeling, storyboards, and paper prototype interviews being reported more frequently than affinity diagramming (see Figure 4). Interview data contradict this picture, depicting usage more in line with that reported in the chapter 1 case studies, with again the most reported technique being CI (13 of 16), and affinity diagramming being the second most reported technique (8 of 16). The cause of the discrepancy between survey and interview data can only be guessed at here. It is possible that people filling out online surveys move quickly through the questions, not necessarily paying careful attention to the framing text or precise terminology. Thus practitioners who reported doing paper prototype interviews may in fact have done laboratory testing of prototypes but checked the item on the survey because it had the word “prototype” in it. Some evidence for this kind of behavior may found in the case of the practitioner who filled out the entire survey but was found in the interview not to have heard of CD itself.

With greater certainty we may conclude that practitioners are unlikely to use the full CD process with any regularity, if ever. The reason for this incomplete use may only partially lie with the preference of the practitioner for other, briefer methods. From the interviews it is clear that many practitioners report projects (or their involvement in the projects) stopping short of the goals addressed by the later steps of the CD process, whether those projects are truncated by job role, early success, early failure, loss of funding, or other conditions. It may be that the later steps of CD are not so much inadequate as they may be irrelevant to some projects.

Efficiency, end in itself, expertise required, and interdisciplinarity? Chapter 2 raised questions of perceived efficiency, whether CD becomes an end in itself, the level of expert guidance required, and the success of CD vocabulary and representations in aiding interdisciplinary cooperation on projects. In the survey, CD was reported to be efficient (median of 2 on a seven-point scale, where 1 was efficient and 7 inefficient).

The interview comments about the cost of CD are also relevant here: CD is efficient if it is suitably tailored to the needs of the project at hand. Blindly doing all the CD steps, or doing unnecessary ones, would not likely yield high ratings for efficiency. Many interviewees as well as survey comments mentioned the need for selecting, adapting, and supplementing CD to yield a good result.

Whether CD as a detailed, explicit process becomes an end in itself seemed almost uniformly answered in the negative, with the exception that people associated with InContext Enterprises were viewed by some as too doctrinaire. Most of the people describing the projects in the interviews were leaders or co-leaders of those projects. It may be important to interview participants in CD projects led by others to see whether the self-perception of practitioners as being able to tailor and adapt CD appropriately is shared by those on the project who do not have a leadership role.

The question of the level of expert guidance required for a successful project received some support from the survey, where 11 of the 86 respondents who commented on the limitations of CD mentioned the need for and difficulty of obtaining the necessary expertise. Only 2 of the interview participants were self-taught, and though they reported their representative projects as successful, those data are too scant to use as counter-evidence. Moreover, the survey responses did not discriminate between expertise required to execute the full process (extensive use) and the expertise required to use a more minimal or derivative process, but to do so effectively (effective use).

Evidence for CD models as a means of aiding multidisciplinary cooperation on design projects is inconclusive. On one hand, the survey data did suggest that the communicative capability of the models was a contributing factor to a major benefit of CD. Yet in the four interviews where the participant reported being part of a multidisciplinary team, only one team was indicated as creating individual models and one other reported creating a consolidated model. The comments of two interview participants about CD being intentionally multidisciplinary did not focus on the models with these comments.

Appeal of CD to Designers. Chapter 3 examined CD in relation to a more general design framework and considered whether designers might prefer general frameworks to the more prescriptive CD process. This idea was broadly rejected by survey respondents, some of whom argued that CD had more appeal to designers than to people from other backgrounds. However, there is some ambiguity in the question, because, as was evident from people's responses to the CD-as-training-wheels metaphor, there is ambiguity in what one means by CD. If the participant is thinking of CD as a framework for thought, or as a best-in-class toolkit, then it is not difficult to understand why either of these concepts might appeal to designers as much as PRInCiPleS would. But if the participant is thinking of CD in the context of the CD-as-religion metaphor, then it may be less appealing to designers—but also less appealing to anyone else, depending on one's degree of maturation as a designer.

Applicability, Model Expressiveness, and Conflict. Chapter 4 raises the question of the applicability of CD to activities that are not "office work," which is the design center of CD. The application of CD to such varied activities as tooth brushing and live-action gaming suggests that CD can have applicability beyond its original design center. Moreover, even if a project does focus on office work, CD may not be successful or even appropriate in all cases. There are many contextual factors practitioners consider when choosing methods and techniques. Survey comments about applicability did not point toward limiting the use of CD to the design of systems only for office work.

Chapter 4 also raises questions about whether and how people adapt the CD work models and whether adding further expressiveness is feasible. Adaptations of models noted in the interviews included combining flow and sequence models together, listing roles in place of flow models, listing intents in place of sequence models, using model types as headings for analysis, and using other means of data expression such as photographs, personas, and scenarios. In the interviews, either individual or consolidated models were reported, but not both. These data suggest that adding further expressiveness to CD models may not be a fruitful direction, given that the reported trend was to skip, combine, or reduce the current models. Practitioners appear to be striving for a more lightweight process rather than a more involved one. Where data was noted as missing (e.g., verbatim quotations), it is not clear these data types fit well into diagrammatic models. Any further expressiveness added to models might be most useful if the CD work models could be used as a means of capturing and publishing scholarly research results about work practice. This is an area left unexplored by the present research, which focused on design practitioners.

Chapter 4 also motivated the question of whether CD exposes and helps resolve conflicts between user needs and organizational objectives. There was broad support for the idea that CD uncovers such conflicts, and nearly as broad support for the idea the CD by itself provides no additional help for resolving these issues—for achieving the kind of "alignment" (as 1 interview participant called it) needed to resolve these conflicts. Lacking a mechanism for addressing these conflicts, CD may need to borrow from other methods, or at least offer a placeholder so practitioners are aware of the need at the beginning. The PRInCiPleS framework, for example, has a strategies component for addressing business issues (Notess & Blevis, 2004).

The failure of those sponsoring CD projects to act on the results may be caused by a naïve assumption, not sufficiently dispelled by the CD book, that if one spreads around enough understanding of customer work practice, good things will happen. But CD does not appear to help practitioners thread their way through the assortment of organizational obstacles and politics standing in the way of meeting user needs.

The Revised Summary Statement

> Contextual design (CD) encapsulates much that people consider valuable in a user-centered design process, both as a guiding framework and as a toolbox of useful techniques. The full process is an externalization, through detailed steps and explicit deliverables, of an idealized design process, optimized for cross-functional teams developing technical solutions. Practitioners tailor CD—through selection, adaptation, and addition—to the situation at hand.
>
> In most cases, the situation at hand will necessitate a process much reduced from the full process outlined in the original CD book because of time and resource constraints, project truncation, or because in many environments clients or management may not see a need for initial field work and user needs analysis. People rarely use the entire CD process or even most of the techniques, but they may often think back on it as a kind of checklist, using the process or models as tools for planning project activities and for focusing attention during

observations and analysis. The parts of CD most likely to be used are CI and affinity diagramming; work modeling, storyboarding, and paper prototyping may be less often used; user environment designs are rarely used. CI and affinity diagramming appear useful well beyond the design center of CD, and are sometimes combined with other techniques such as requirements definition, personas, and laboratory-based testing of prototypes.

Even those CD practitioners reporting a high level of CD knowledge do not usually make full use of the process even if they value the entire process. They find that certain steps are better addressed through other techniques. The entire process need not always be externalized, depending on the communication needs within and beyond the team. Some of the value they derive from CD is the sense of what matters—the principles of data, team, and design thinking outlined in chapter 1. As these principles can be embodied in techniques other than those of CD, CD serves as a carrier for these values, but it is not always perceived as the best implementation of those values.

CD does not do everything. In particular, it does not provide a way to resolve the political issues arising from conflicts it uncovers between user needs and the goals of the sponsoring organization, conflicts often arising from the broadening of scope that CIs can cause.

Limitations and Achievement

One limitation of both the survey and the interviews is that neither probed deeply into the nature of the design team, when there was a team. To understand the experience of CD by members of a multidisciplinary project team, it would be important to talk with all members of the team of a single project, something avoided in the interview stage because of the desire to learn about a wide variety of contexts, as opposed to a range of roles within a single project. Even the case studies reported in chapter 1 tended to focus on the data rather than on the composition of the design team or the effectiveness of the models in communicating across disciplines.

Another limitation of the both the survey and the interviews is the likely skew in the results because of who responded. People who have learned about CD but never used it were perhaps less likely to respond to the initial survey. The interviews targeted practitioners who had relatively more experience with CD and had more to say about it. Because of these factors, the present research provides little insight into why a practitioner might reject CD entirely. An ambiguity underlying both the survey and the interviews is the definition of CD itself. How few of the CD steps can one use before the process is no longer CD? If one merely does CI, is that also CD? It was beyond the scope of this research to try to pin down a generally accepted definition of the boundaries of CD.

This chapter provides an account of how people who know about CD have reported using it, and how they characterize its utility and impact on themselves as practitioners. Unlike earlier methods surveys, the survey reported in this chapter focused only on CD and was therefore able to present a preliminary account of which techniques are more used and the benefits and limitations of CD as perceived by respondents. Building on the survey response, the interviews provided a deeper account of the decisions practitioners make about CD and the influences on those decisions. Both studies were international in scope and provided data across a wide range of work environments. Data from both studies led to substantial revision of the summary statement that was based on earlier chapters.

6. IMPLICATIONS FOR THE DESIGN OF EDUCATIONAL TECHNOLOGIES

The previous chapters, and in particular chapter 5, address the primary research objective of this dissertation: to provide an account of how those who have learned about contextual design make use of it, and how they characterize it. This final chapter draws on this account, along with the education-related questions raised in chapters 1, 2, and 4, to address the secondary research question: How might CD be useful in developing educational technologies? As this dissertation is fundamentally exploratory, recommendations in this section are primarily recommendations for further investigation.

Beneficiaries

At the end of chapter 1 three groups of potential beneficiaries from this work were identified: developer-designers of instructional places or interactive materials, educators of instructional designers who will work with software developers, and educational researchers and their graduate students. This section considers what value the foregoing research offers these constituencies along with what further work may be necessary.

Developer-Designers of Instructional Places or Interactive Materials

In chapter 1 the emergence of new technology-based *places* where learning and instruction happen was described. Course management systems, virtual classrooms, and 3-D virtual worlds are examples of the kinds of places educators and learners are using to accomplish educational objectives. In addition, online interactive learning materials such as Flash-based tutorials or instructional websites are proliferating in many learning contexts. The people (or teams) designing and building these places and materials operate in multiple domains, including areas traditionally addressed by software developers and areas traditionally addressed by instructional systems designers. In chapter 2 the dichotomy and unity of interests between these two roles were explored. What might CD offer to these individual designer–developers or to such teams?

Using the two strongest metaphors from chapter 5, it is possible to suggest that CD offers a guiding framework and a toolbox. ISD has its own frameworks and techniques, but the focus of ISD methods tends to be on the design of instructional interventions or materials. As was mentioned in chapter 1, the standard ISD curriculum as represented by its textbooks does not offer a framework or toolbox to help instructional designers participate with technology developers on an interdisciplinary team tasked with developing a technology-based system.

The guiding framework may help in such areas as project planning, knowing what to notice during field observations, and knowing how to analyze and communicate data to other stakeholders. One of the strongest values of CD is context, and its most used technique is contextual inquiry. Designer–developers could decide that, instead of making up requirements from their preferences and ideas, or even their remembered experience, they will observe the activity they intend to support or improve, addressing the various roles involved, the intents being pursued, the breakdowns that occur, the cultural/emotional issues that emerge, and the artifacts used (to name some of the most frequently mentioned model elements). Then, in follow-up discussions with the people they observed, designer–developers can test the soundness of their interpretations. Next, depending on the schedule and resources available and the number of personnel involved, the field data can be used as the basis for work models (most expensive), work notes for an affinity diagram (less expensive), or simply mined for insights, design ideas, and eventually requirements (least expensive). With any of these options, personas, scenarios, or some other non-CD communicative representation can be created if there are other stakeholders who would benefit from attaining the same understanding.

An area for further research is to examine the tradeoffs of these “discount” CD methods, particularly in educational contexts. Practitioners need to know what they are giving up and gaining by choosing a discount version of a method. Having a range of identifiable front-end methods with known properties could help practitioners promote such methods responsibly and effectively, perhaps eventually gaining the recognition and acceptance some interview participants reported to be enjoyed by usability evaluation methods. A related area of work would be to explore or define “discount” ISD methods because, as was noted in chapter 2, ISD methods are sometimes criticized as being resource-intensive, like CD. Perhaps streamlined ISD methods could be integrated with streamlined CD to provide a compelling approach to educational technology development.

An important finding from chapter 5 is the potentially “incendiary” nature of user data. Before embarking on an altruistic quest to discover user needs, designer–developers should consider who the stakeholders are, what the larger organizational objectives are, and who is likely to react negatively depending on the findings. CD does not offer help with this process, nor does it suggest how to work through the problems that result from people feeling threatened by user data. An area for further research would be to examine the kinds of power issues surrounding user data in educational contexts, whether in university information technology groups, school districts, or educational technology companies. One characteristic of educational contexts is that they may be somewhat more susceptible to designer–developers and their management believing their experiences as students or instructors provide sufficient understanding of user needs since they have all been either students or instructors or both. Thus another area for research is the attitudes of technologists and technical management in education toward user needs analysis and field work in particular.

In chapter 4 the question was raised of whether the work models need to be made more expressive so that they can better represent learning activity. The research in chapter 5 suggests this may not be a useful direction. While such enhancement of the modeling constructs might yield a better representation of learning activity, the creation of the current models is already sufficiently laborious that one or both of the modeling and model consolidation steps are omitted by practitioners. Instead, a potentially more useful path of research is simplification of modeling constructs and streamlining of modeling and consolidation procedures such that field data can be analyzed and shared more efficiently than is now possible. Or it may be that model-based representations of work practice will never achieve broad acceptance by practitioners and that other approaches such as personas and scenarios should be promoted instead. This is also an area for further research.

Another direction for inquiry would be to investigate the feasibility and value of CD work models for scholarly research in teaching and learning, using the models in their present form or developing other, more expressive forms. Scholarly researchers may have the need for extra expressiveness and may benefit from diagrammatic representations as an adjunct to textual descriptions in the reporting of qualitative field-research results. Chapter 1 identified the problem of CD-based case studies providing only limited description of their results and few examples of model usage. These limitations may become less relevant as online scholarly publication venues offer either fewer length limits or the opportunity for direct linking to additional materials online.

Another issue from chapter 4 is whether CD is too externally focused to address an activity such as learning, which is often characterized by internal, psychological activity. This is not merely an issue for the modeling constructs: it is also a potential issue for CI, which relies on establishing a shared interpretation of observable activity. Research methods from educational and cognitive psychology may be better ways to study some kinds of learning activity than is CI. An area for further inquiry is whether there are ways to enhance or adapt CI to address internal activities more effectively, drawing on research methods from psychology but modifying them for use in a design environment.

The work described above is just the front end of the design process. CD offers guidance and techniques for addressing the later stages of design as well—creating and iterating prototypes. A question for further research is whether these later steps of CD are less used than others solely because so many projects do not go that far, or because the techniques themselves are not as compelling to practitioners.

In chapter 5 support was found support for the idea that conflicts between user needs and organizational objectives can be uncovered by CD but that CD does not help resolve those conflicts. In chapter 4 an example of this kind of conflict was described: some students may prefer to adopt a surface learning strategy when the instructor or department wants students to adopt deep learning strategies (Entwistle, 2000). The question then becomes whether to meet the desired work practice of the user as well as supporting the work practice desired by the instructor. Designer–developers should not expect CD to help them resolve this conflict. At best, it can provide data demonstrating that some students do indeed wish to adopt surface learning strategies, and data can illustrate the process whereby students do so. But, as one interview participant commented, the resolution of these kinds of conflicts may belong in a bar. CD is better at discovering and describing what *does* happen in a particular context than it is at deciding what *should* happen in the face of conflicting objectives. Research accounts of the political contexts in which educational technology development occurs could help practitioners anticipate what conflicts might arise from uncovering user work practice. An area for further research is to explore techniques for gaining greater alignment between user needs and organizational objectives and then integrating those techniques with CD and ISD techniques. How is it that technology managers come to care about user needs? What are the formative experiences or conceptual breakthroughs that move them in that direction?

Educators of Instructional Designers

A second category of potential beneficiary for the present research identified in chapter 1 is educators who want to prepare their students for effective interdisciplinary collaboration on the design of technology-based learning environments. Specifically, a potential role was seen for CD as a means of preparing instructional designers to bridge the gap between themselves and software developers. For this role to be compelling, it must be clear that CD is effective in bridging this gap, and it must also be clear that studying CD as a student offers sufficient preparation to bridge that gap.

Interview data reported in chapter 5 was characterized as inconclusive on the question of whether CD models aided multidisciplinary cooperation on design projects. However, evidence from the survey did point more strongly to the value of the process overall in bridging gaps on an interdisciplinary team: “the resulting shared understanding on the team and among stakeholders” was one of the main categories of benefits attributed to CD (11 mentions). An area for further investigation is the exact nature of the gap between instructional designers and developers in different contexts where the groups work together. Is the gap one of assumptions? terminology? mode of operation? motivation? With a better understanding of the nature of this gap, techniques from HCI or other fields could be more carefully selected by instructors training instructional designers.

The second question is whether studying CD as a student prepares ISD students sufficiently to be able to bridge the gap between themselves and software developers. Fairly strong support was found during the interviews for the pedagogical value of CD. Even though the CD-as-training-wheels metaphor did not prove to be the most compelling metaphor, it did receive some support. Moreover, the two primary metaphors—guiding framework and toolbox of best-in-class techniques—both suggest pedagogical value. However, the research reported in chapter 5 did not specifically examine the resulting competence of those who study CD as students: it is not known what they are capable of doing when finished, so this remains an area for further research.

For instructional design curricula where there is an emphasis on designing technical systems or interactive materials, chapter 5 can offer some preliminary guidance to instructors as to which parts of CD may be most useful to include. For example, the "lightning fast" flavor of rapid CD (Holtzblatt et al., 2005, pp. 37–40) is a fairly close match with the scaled-down process used by some of the interview respondents and therefore similar to the scaled-down process recommended for consideration by designer–developers in the first section of this chapter. Possibly the "lightning fast" reduction could work well as a unit in a semester-length class or a 3-day training course. One concern with this very scaled-down curriculum is that omitting work modeling may mean that some aspects of work practice represented in the model constructs are ignored by students conducting inquiry and analysis. Thus an area for further research is pedagogical approaches to teaching about the structure of work practice. It may be that a set of work-practice heuristics (as the modeling constructs were used by one interview participant), could be an adequate replacement for practice in actually creating the models. A preliminary set of heuristics could be derived from a comparison of CD models and activity theory, for example.

Having taught CD myself in both academic and training contexts, I expect my pedagogical practice to change as a result of the present research. In particular, I anticipate putting more emphasis on the underlying concepts as a guiding framework, using design cases to demonstrate how CD techniques can be selected, tailored, and supplemented to address the situation and constraints at hand, and finding ways to alert students to the political issues engendered by user data. I also hope to explore approaches supplementary to CD that can help students address political issues within development organizations.

Educational Researchers and Their Graduate Students

The third category of potential beneficiary for the present research is educational researchers and their graduate students who collaborate on projects involving the design of technology-based places for education or of interactive educational materials. For such people this research offers several potential benefits related to research proposals, project planning, and staff development.

The findings in chapter 5 suggest there may be some value in offering CD as a “known method” in a research proposal. The cost and resource requirements of CD that can discourage uptake by some clients or managers might be an asset in a research program, where the sponsors of the research want the assurance that their funding will be used according to documented, well-known methods. Having the option of putting an established HCI design process such as CD into a proposal may also make sense for some funding agencies or clients, if they are more familiar with HCI than with ISD. Chapter 2 results suggest that systems design and instructional design are compatible. Depending on their backgrounds, systems developers may be more comfortable thinking of their work in the context of HCI design frameworks than in the context of instructional design frameworks—and funding agencies or clients may have the same preferences. Being able to lead with one or the other and knowing how they connect can help build a compelling process argument. The more recently published rapid CD process definitions offer a means of characterizing where a proposed process falls on the cost and complexity scale. Chapter 5 findings indicated that field study methods lack an accepted product line ranging from inexpensive to expensive, but CD itself has the benefit of offering a range of variants.

A second potential benefit of this research, suggested by the findings in chapter 5, is that CD may function as a project-planning framework, at least for the front end of the development process. Using CD steps heuristically can offer an approach to thinking through what roles and activities are necessary as part of the planned research. Chapter 5 findings also offer some help in determining when steps might be considered for omission, or whether other non-CD techniques should be considered for supplementary use.

Finally, many educational research projects are conducted at research universities with graduate students doing much of the work. For students who may not have experience with the concepts and techniques embodied in CD, this research suggests that the pedagogical value of CD may enable CD to provide a kind of personal development plan graduate students can work through during project development. Since the research in chapter 5 did not focus on projects in academic settings (although several were reported by participants), further investigation is needed into how effectively self-taught graduate students can select, adapt, and augment CD techniques in the context of a research project. The idea of self-taught practitioners being able to use CD effectively received some counterevidence from the survey results in chapter 5, which indicated that scarce expertise was one limitation of CD. However, as also pointed out in chapter 5, the survey did not provide insight into whether that comment applied to the use of even a minimal set of CD techniques or just to the process as a whole.

Conclusion

Motivated by the increased need for instructional designers to collaborate with technologists in the design of systems and interactive materials, the present research examines a distinguished example of a human-centered design approach that has been available for over 10 years. Newer formulations, such as the persona lifecycle (Pruitt & Adlin, 2006), should they become broadly known and accepted, could benefit from similar examination, both as HCI methods generally and as possible candidates for broader use by educational technology design practitioners, by trainers of such practitioners, and by educational technology researchers. Meanwhile, the present study serves as a basis for preliminary ideas on how CD can be of use in ISD, suggests possible directions for further research to refine those ideas, and may also serve as a model for future research into how design approaches and techniques can be assessed for the benefit of educational technology design.

This research did not examine the practice of instructional designers but instead examined reported practice of CD by HCI practitioners. Perhaps the most important next step in this line of research is to examine in detail a case where instructional designers participate in a larger design project also involving software developers. The Sakai project (www.sakaiproject.org) offers one such opportunity. This line of research should examine the question of how user needs are uncovered and represented, how those needs conflict with other project objectives, and how (and by whom) those conflicts are resolved. Such research should also examine the role of instructional designers in the larger design process, as well as the language and representations they use to communicate their contributions.

Studies of methods use are important to the field of HCI and to ISD as well. The ambiguities of some of the survey results offer caution to those who would study methods use by surveys only. In the present study, the survey results were perhaps most useful as a guide to selecting interview participants and as a means of identifying questions that could be explored in the interviews. Future studies of methods use, whether broad or deep, may be more useful than previous ones if they adopt an approach that moves beyond survey research.

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APPENDIX A. SURVEY

Contextual Design Survey

The Indiana University Schools Education and Informatics are conducting research into people's use of Contextual Design, an approach to customer-centered design developed by Karen Holtzblatt and Hugh Beyer. This approximately 5-minute survey is for people who already know about or have used Contextual Design.

If you are willing to participate in an approximately 20-minute phone interview about Contextual Design, please provide your name and email address below. Your contact information will only be used for the purposes of conducting this research. Your survey and interview responses will be reported anonymously, and your participation in this research will not be revealed to third parties.
Name: ____________________ (optional)
E-mail: ____________________ (optional)

1. How much do you know about Contextual Design?
○ a lot
○ some
○ a little

2. How did you learn about Contextual Design (check any that apply)?
☐ attending a tutorial at a conference
☐ reading the Beyer & Holtzblatt book, *Contextual Design*
☐ reading the Holtzblatt, *et al.*, book, *Rapid Contextual Design*
☐ reading other articles or book chapters
☐ attending training provided by InContext Enterprises
☐ studying the process as part of an academic class
☐ teaching the process in a class setting
☐ other—please specify: ____

If you have never used Contextual Design, please skip to <u>question 5</u>.

3. Which parts of Contextual Design have you used (check any that apply)?
☐ contextual inquiry
Work modeling:
  ☐ flow models
  ☐ sequence models
  ☐ culture models
  ☐ physical models
  ☐ artifact models
Consolidation:
  ☐ consolidation of any of the above work models
  ☐ affinity diagram of work notes
Work redesign:

☐ walking the data
☐ visioning
☐ storyboarding
☐ user environment design diagram
☐ paper prototype interviews

Where have you used Contextual Design (check any that apply)?
☐ for a project in a class
☐ for a work-related project
☐ other—please specify: ____

4. Think about the work-related project that you consider to be your most recent use of Contextual Design and answer the questions below. **If you have not used Contextual Design in a work-related project, please skip to question 5.**

How many people on the project participated in using Contextual Design? ____
How many contextual inquiries were conducted? ____
How many prototype interviews were conducted? ____

Who provided the Contextual Design expertise on this project (check all that apply)?
☐ yourself
☐ someone from Incontext Enterprises
☐ another external consultant ___________________ (name of consultant)
☐ internal person ____________________ (position title)
☐ other—please specify company or position: ____________________________

Which parts of the Contextual Design process did you use (check all that apply)?
☐ contextual inquiry
Work modeling:
☐ flow models
☐ sequence models
☐ culture models
☐ physical models
☐ artifact models
Consolidation:
☐ consolidation of any of the above work models
☐ affinity diagram of work notes
Work redesign:
☐ walking the data
☐ visioning
☐ storyboarding
☐ user environment design diagram
☐ paper prototype interviews

How successful do you feel Contextual Design was for this project (circle a number)?
successful 1 2 3 4 5 6 7 unsuccessful

How efficient do you feel Contextual Design was for this project (circle a number)?
efficient 1 2 3 4 5 6 7 inefficient

For the parts of Contextual Design you used, how closely did you follow the Contextual Design process?
closely 1 2 3 4 5 6 7 loosely

5. How likely are you to use Contextual Design in the future?
likely 1 2 3 4 5 6 7 unlikely

6. What do you see as the main benefits of Contextual Design?

7. What do you see as the main limitations of Contextual Design?

[Submit Survey] (may take a few seconds—please press only once!)

Thank you for your time!

APPENDIX B: INITIAL SURVEY PARTICIPANT RECRUITMENT E-MAIL

<personal introduction if this is a personal email to someone I know>

Do you know about Contextual Design?

If you have learned about Contextual Design through reading books or articles, taking a class, or through any other means, please help our research by answering a brief 5-minute survey about your knowledge and use of Contextual Design.

In addition, we would like to interview a subset of people who complete the survey regarding Contextual Design. If you are willing to participate in an approximately 20-minute phone interview on this topic, please provide your name and contact information at the beginning of the survey.

For important details about this study, please see the Study Information Sheet below. If you are willing to take the survey, please click on the URL below.

<URL>

If you know others who have experience with Contextual Design, please forward this complete message to them.

Thanks for your assistance,

Mark
--
Mark Notess
Indiana University
mnotess@indiana.edu
(812) 856-0494

Study # 07- 11774

INDIANA UNIVERSITY - BLOOMINGTON
STUDY INFORMATION SHEET

Investigation of Contextual Design Use

You are invited to participate in a research study. The purpose of this study is to understand how people who have learned about Contextual Design make use of that process.

INFORMATION

All participants are invited to fill out an approximately 5-minute online survey. If you are willing to be interviewed by phone regarding your use of Contextual Design, please provide your name and contact information at the end of the survey. If you are selected for a phone interview, you will be contacted by email to arrange a time for an approximately 20-minute phone interview regarding your use of Contextual Design. Up to 20 people will be interviewed by phone.

With your permission, the phone interview will be recorded so that the interviewer can correct or complete the notes from the interview.

BENEFITS

The main benefit of this research is to add to the body of knowledge of how design methods are used by those who have learned them.

CONFIDENTIALITY

After the interviews are completed, all identifying information will be destroyed. No data reporting will give identifying information. Recordings and identifying information will be destroyed by December 2008.

CONTACT

If you have questions at any time about the study or the procedures, you may contact the researcher, Mark Notess, at 3602 E. Winston St., Bloomington, IN, USA, 47401; telephone, 812-856-0494; email, mnotess@indiana.edu.

If you feel you have not been treated according to the descriptions in this form, or your rights as a participant in research have not been honored during the course of this project, you may contact the office for the Indiana University Bloomington Human Subjects Committee, Carmichael Center L03, 530 E. Kirkwood Ave., Bloomington, IN 47408, 812/855-3067, or by e-mail at iub_hsc@indiana.edu.

PARTICIPATION

Your participation in this study is voluntary, you may refuse to participate without penalty. If you decide to participate, you may withdraw from the study at anytime without penalty and without loss of benefits to which you are otherwise entitled. If you withdraw from the study before data collection is completed your data will be returned to you or destroyed.

Information Sheet date: 19 February 2007

Follow-Up Survey Participant Recruitment/Reminder Email

If you have not already done so, please consider helping with the Contextual Design research survey described below. It should only take about 5 minutes to fill out the survey. If you have already filled out the survey, thanks for your help!

Best,

Mark

APPENDIX C. INTERVIEW QUESTIONS

1. What is your occupation? Your role in system design?
2. Tell me about how you learned Contextual Design.
3. How much have you used it? Please describe a representative project.
    a. What as the design problem being addressed?
    b. How many people, representing what areas of expertise, were involved?
    c. What parts of CD were used? How were they adapted?
    d. In particular, which work models were used, if any? How adapted?
    e. Were there kinds of data not covered well in the work models? If so, how were such data represented or communicated (if they were)?
    f. What parts of CD were not used? Why?
    g. What other methodologies were used? How did they integrate with CD? What did they add?
    h. Did you note any conflicts between user needs and organizational objectives? If so, did CD help expose and or resolve any of these conflicts, and if so, how?
4. What do you like best about CD? Least?
5. Please comment on the extent to which you believe CD enables interdisciplinary cooperation on design projects.
6. What value have you derived from your knowledge of CD?
7. What value have you derived from your practice of CD?
8. How does CD compare to other design processes you have used?

APPENDIX D. INTERVIEW RECRUITMENT EMAIL

Dear <Name>,

Thanks for being willing to participate in a phone interview to discuss Contextual Design. If you are still interested being interviewed, please let me know when are the best times to reach you, and confirm your phone number as XXX-XXX-XXXX. I will reply with a proposed time. I have again attached the study information sheet below—please review it to be sure you are willing to participate.

If you no longer wish to participate by being interviewed by phone, just let me know and I will not contact you about this again.

Kind regards,

Mark

<SIS from appendix B attached here>

CURRICULUM VITAE

MARK NOTESS

Education

Ph.D. Instructional Systems Technology, Indiana University, 2008

Thesis title: An Assessment of Contextual Design and Its Applicability to the Design of Educational Technologies

Doctoral minor: Human-Computer Interaction

M.S. Computer Science, Virginia Tech, 1988

Area of concentration: Human-Computer Interaction

M.A.Ed. Curriculum and Instruction, Virginia Tech, 1981

Area of concentration: Teaching English as a Second Language

B.A. English, Virginia Tech, 1979

Research Interests

Human Computer Interaction – design and evaluation methodologies, contextual design, ethnographic research, activity theory, lived experience of everyday computing

Learning Technologies – in higher education, adult learning, older adults; online learning environments and tools; digital libraries

Professional Experience

Development Manager, Digital Library Program, Indiana University, 2004-present

Project management for Variations2 ($3M NSF/NEH funded) and Variations3 ($768K IMLS funded) digital music library projects. Software is in heavy daily use at IU and is being implemented at six other schools. Led requirements and usability work on Sakaibrary project ($438K Mellon funded). Managing requirements for IU Libraries website.

Usability Specialist, Digital Library Program, Indiana University, 2001-2004

Led user research for Variations2 project. Led interaction and visual design, contributing in Java programming as well.

Adjunct Instructor, School of Library and Information Science, Indiana University, 2002-2003

Designed and taught two project-based graduate HCI courses.

Interim Director, SLIS Usability Laboratory, Indiana University, 2001-2003

Managed usability lab including equipment selection, documentation, and lab utilization.

Director of User Experience, Unext, 2000-2001

Managed large user experience team at a higher education startup company. Led process definition and improvements; hired and developed user experience staff. Authored executive education courses in project management and internet user experience, the latter with Don Norman.

Learning Portal Program Manager, Agilent Technologies, 1999-2000

Program managed a company-wide education web portal project that included training administration, collaborative tools, online learning, and professional development tools. Worked with business units and corporate groups world-wide to refine and prioritize requirements. Led company-wide team in portal vendor evaluation. Consulted with Agilent's company-wide intranet design team.

Productivity and Quality Manager, Hewlett-Packard, 1997-1999

Led process improvement and user centered design initiatives for a 100-person software development lab; assessed training needs and developed lab-wide training curriculum; participated in company-wide customer focus team; initiated cross-organizational customer focus team for $.5M server product.

Project Manager and Senior Software Engineer, Hewlett-Packard, 1993-1997

Defined GUI toolkit product and built a team of six engineers to develop and deliver the software, used by several HP software products. Initiated and led lab-wide user-centered design effort; retained Karen Holtzblatt as external consultant to help with successive projects. Managed human factors and visual design resources for lab. Worked closely with other divisions and companies to align Unix user interface strategy.

Software Design Engineer, Hewlett-Packard, 1988-1993

Prototyped, designed and developed system administration GUI tools for HP's Unix operating system (HP-UX). Evaluated third-party user interface tools; developed successful partnership with a small software company in Germany. Designed and conducted survey to evaluate experience of customer support organization with our product. Led cross-lab user interface design and technology efforts.

Graduate Research Assistant, Computer Science, Virginia Tech, Spring 1988

Designed and conducted user interface evaluation research.

Graduate Teaching Assistant, Computer Science, Virginia Tech, Winter 1988

Taught undergraduate computer literacy class.

Instructional Designer, Virginia Cooperative Extension Service, 1987

Full-time instructional designer on an interactive videodisc project grant.

Computer Programmer (part time), Virginia Cooperative Extension Service, 1985-1987

Designed and implemented a variety of educational software, including a multimedia authoring system.

Instructor, English Language Institute, University of Alabama, 1982-1985

Instructor, English, Western Carolina University, Summer 1982

Graduate Teaching Assistant, Instructor (part time), English, Virginia Tech, 1979-1982

Software Developed

Variations3 (2006-present). Redesign of Variations2 to enable use beyond IU. Currently in pilot deployment at six colleges and universities. The audio annotation Timeliner is being open-sourced to allow even broader use. Java-based client program is being redesigned as an AJAX-based web application based on data from user studies.

Sakaibrary (2006-2007). Sakai tool for creating and managing citation lists brings licensed library content into the course management system, obviating the need to copy and paste URLs that are often non-persistent. Built within the Sakai resources tool.

Variations2 (2001-2007). Digital music library with novel search function, access to streaming audio and scanned score images, with rich pedagogical tools for close study, annotation, presentation, and self-test. Heavily used at IU Jacobs School of Music. Java client-server application, with client running on both Windows and OSX operating systems.

ObAM (early 1990s). Unix-based user interface toolkit allowing non-UI programmers to easily create consistent object-action systems management applications that run on both X/Motif and character-mode terminals. Used by multiple projects within HP. Originally written in C. Later re-implemented in Java.

Recipe (ca. 1985). DOS-based nutritional analysis program replacing a complex mainframe application. Users select ingredients from lists to assess nutritional content. Written in Pascal.

PC-Teach (1986). A simple DOS-based authoring environment for instructional content. Allowed non-programmers to combine graphics, music, and text. Written in Pascal.

Awards and Patents

Notess, M.H., Warren, S.J., Heiserman, T., & Kingdom, M. *Object-action user interface management system,* U.S. Patent No. 958205, awarded in 1995.

Hewlett-Packard/UDL “Drive the Future” award, once in 1990 and again in 1994

Hewlett-Packard Customer Awareness Champion Award

Tuition Grant Scholarships, Computer Science, Virginia Tech

Graduate Teaching Assistantship, Computer Science, Virginia Tech

Graduate Teaching Assistantship, English, Virginia Tech

Member, Phi Beta Kappa

Publications

Refereed

Notess, M. (2005). Understanding and representing learning activity to support design: A contextual design example. In *Proceedings of Association for Educational Communications and Technology 2005*, Orlando, Florida (October, 2005).

Notess, M., Kouper, I., & Swan, M. (2005). Designing effective tasks for digital library user tests: lessons learned. *OCLC Systems & Services: International Digital Library Perspectives*, 21 (4), pp. 200-310.

Notess, M. (2004). Three looks at users: a comparison of methods for studying digital library use. *Information Research*, *9*(3).

Notess, M., & Blevis, E. (2004). Comparing human-centered design methods from different disciplines: contextual design and PRInCiPleS. In Redmond, J., Durling, D., & de Bono, A., eds., *FUTUREGROUND, Proceedings of the Design Research Society International Conference 2004*, Melbourne: Monash University.

Notess, M., Riley, J., & Hemmasi, H. (2004). From abstract to virtual entities: implementation of work-based searching in a multimedia digital library. In *Research and Advanced Technology for Digital Libraries*. Berlin / Heidelberg: Springer, pp. 157-167.

Notess, M., & Dunn, J.W. Variations2: improving music findability in a digital library through work-centric metadata. In *Proceedings of the 4th ACM/IEEE-CS Joint Conference on Digital Libraries JCDL '04*, Tuscon, Arizona (June 2004).

Notess, M. & Swan, M. (2004). Timeliner: building a learning tool into a digital music library. In *Proceedings of ED-MEDIA 2004*, Lugano, Switzerland (June 2004).

Swan, M.B., & Notess, M. (2003). Predicting user satisfaction from subject satisfaction. In *CHI '03: CHI '03 Extended Abstracts on Human Factors in Computing Systems*, Ft. Lauderdale, Florida (April 2003) pp. 738-739.

Curtis, P., Heiserman, T., Jobusch, D., Notess, M., & Webb, J. (1999). Customer-focused design data in a large, multi-site organization. *In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems: The CHI Is the Limit CHI ’99*, Pittsburgh, Pennsylvania (May 1999), pp. 608-615.

Lundell, J., & Notess, M. (1991). Human factors in software development: models, techniques, and outcomes. In *Proceedings of the SIGCHI Conference on*

Human Factors in Computing Systems: Reaching Through Technology CHI '91, New Orleans, Louisiana (May 1991), pp. 145-151.

Invited

Notess, M. (2005). Contextual design of online learning technologies. In Howard, C., et al., eds. *Encyclopedia of Distance Learning*. Hershey, PA: Information Science Publishing.

Notess, M. (1993). A user interface management system for HP-UX system administration applications. *Hewlett-Packard Journal*, June 1993, pp. 80-84.

Reviewed

Dunn, J. & Notess, M. (2007). Sakaibrary in 2.4: user feedback guides development. *7th Sakai Conference*, Amsterdam (June, 2007).

Notess, M. & Lorenzen-Huber, L. (2007). Online learning for seniors: Barriers and opportunities. *Elearn Magazine* (May 2007).

Notess, M. (2007). Of hot tubs and Beowulf: e-learning for seniors. *eLearn Magazine* (June, 2007).

Dunn, J.W., Byrd, D., Notess, M. Riley, J., and Scherle, R. (2006). Variations2: retrieving and using music in an academic setting. *Communications of the ACM* (August 2006), pp. 53-58.

Notess, M., & Neal, L. (2006). “Deep” thoughts: do mandatory online activities help students leave surface-learning behind? *eLearn Magazine* (June, 2006).

Neal, L. & Notess, M. (2005). The value of voice. *eLearn Magazine* (December, 2005).

Notess, M. (2005). Using contextual design for digital library field studies. *D-Lib Magazine* (July/August 2005). Position paper presented at Presented at the JCDL 2005 workshop, *Studying Digital Library Users In the Wild: Theories, Methods, and Analytical Approaches*, Denver, June 2005.

Notess, M. (2004). Applying contextual design to educational software development. In A.-M. Armstrong (Ed.), *Instructional design in the real world: a view from the trenches*. Hershey, PA: Idea Group Publishers.

Notess, M., & Minibayeva, N. (2002). *Variations2: toward visual interfaces for digital music libraries*. In *Proceedings of the Second International Workshop on Visual Interfaces to Digital Libraries at the ACM+IEEE Joint Conference on Digital Libraries*. Access: http://vw.indiana.edu/visual02/Notess.pdf.

Notess, M., & Plaskoff, J. (2002). Preliminary heuristics for the design and evaluation of online communities of practice systems. *eLearn Magazine* (December 2002).

Notess, M. (2001). Usability, user experience, and learner experience. *eLearn Magazine, 2001,* 3.

Catterall, B.J., Harker, S., Klein, G., Notess, M., & Tang, J.C. (1990). Group HCI design: problems and prospects. *ACM SIGCHI Bulletin*, 22 (2), pp. 37-41.

Technical Reports

Notess, M. (2006). Using Sakai in distance education: a case study. Access: http://bugs.sakaiproject.org/confluence/download/attachments/31147/Notess-sakai-DE-case-study.pdf.

Kouper, I., & Notess, M. (2005). Variations2 contextual observations report: installation and use. Access: http://variations2.indiana.edu/pdf/home-install-report.pdf.

Kouper, I., & Notess, M. (2005). Usability test report: working with scores. Access: http://variations2.indiana.edu/pdf/antest-final-report.pdf.

Notess, M. (2005). Variations2 usability studies: a report for the project midterm review. Access: http://variations2.indiana.edu/html/v2-usability-findings-nov2002/index.htm.

Swan, M., & Notess, M. (2002). MMTT prototypes usability testing first-round report. Access: http://variations2.indiana.edu/pdf/mmtt-usab-test-1.pdf.

Presentations

Refereed

Notess, M. (2004). Can course management systems embrace discipline-specific media and learning tools? a case study of music. Presented at *International Society for Scholarship of Teaching and Learning* (IS-SOTL), Bloomington, Indiana (October 2004).

Notess, M. (2003). Three looks at users: a comparison of methods for studying digital library use. Presented at *Toward a User-Centered Approach to Digital Libraries* (Espoo, Finland, September 2003).

Invited

Educause Podcast (2007). An interview with Mark Notess, development manager & usability specialist at Indiana University. *Educause 2007,* Seattle, Washington (recorded October 25, 2007).

Notess, M. (2006). Sakai usability: where we are, where we need to be, and how to get there." Presented at the *6th Sakai Conference U-Camp*, Atlanta (December, 2006).

Bonk, C.J. & Notess, M. (2004). Getting our ducks in a row: can open source software transform higher education? Presented at *Open Source Summit*, Scottsdale, Arizona (December 2004).

Notess, M. (2004). Variations2 overview and demonstration. Presented at the *British Library and JISC Online Audio Evaluation Workshop,* London, England (October 2004).

Notess, M. (2004). Is e-learning solitary confinement? Presented to the Rochester (NY) e-Business Association, March 18, 2004.

Notess, M., & Rockwell, C. (1995). Team-based contextual inquiry. Presented at the *HP Customer Work Innovation Network Conference*, Palo Alto, California (November 1995).

Reviewed

Notess, M. (2007). Levels of UX design knowledge. Presented at the *7th Sakai Conference U-Camp*, Amsterdam (June, 2007).

Notess, M. (2006). Using Sakai in distance education: a case study. Presented at the *6th Sakai Conference,* Atlanta (December, 2006).

Notess, J., Dunn, J., & Hollar, S. (2006). Sakaibrary update: Initial user responses and next steps. Presented at the *6th Sakai Conference*, Atlanta (December, 2006).

Notess, M. & Lorenzen-Huber, L. (2006). Online learning for seniors: barriers and opportunities. Presented at *Aging by Design*, Boston, October 2006.

Notess, M., & Dunn, J. (2006). Sakaibrary: linking library resources into the learning environment. Presented at the *5th Sakai Conference,* Vancouver, Canada (May, 2006).

Dunn, J.W., Scherle, R., & Notess, M. (2005). Flipping the switch: lessons learned from a major digital library migration project. Presented at the *Digital Library Federation Fall 2005 Forum* (Charlottesville, Virginia, November 2005).

Swan, M., & Notess, M. (2004). Variations2 help: moving help closer to users. Presented at *Helping Users to Use Help: Improving Interaction with Help Systems*, an ACM CHI 2004 workshop, Vienna, Austria (April 2004).

Notess, M. (1995). Short presentation on HP-UX user interface plans. *InterWorks* (HP Workstation User's Group Conference), Phoenix, 1995.

Notess, M. (1992). The SAM user interface architecture: pursuing quality and productivity through an application-specific UIMS. Presented at the *HP Software Engineering Productivity Conference*, 1992.

Other Presentations

Notess, M. (2007). Libraries in Facebook and Second Life: demos and discussion. Indiana University Digital Library Program brownbag series (December 2007).

Dunn, J.W., Smail, S., & Notess, M (2006). Sakaibrary: integrating licensed library resources with Sakai. Indiana University Digital Library Program brownbag series (November 2006).

Notess, M. (2004). Variations2: moving beyond access to pedagogy. Indiana University Digital Library Program brownbag series (September 2004).

Notess, M. (2004). Studying digital library use. Indiana University Digital Library Program brownbag series (April 2004).

Consulting & Paid Reviews

Pearson Education, 2007

National Terrorism Preparedness Institute, 2006

Elsevier / Morgan Kaufmann, 2004, pre-publication book review

Professional Memberships and Service

Member, Editorial Advisory Board, *eLearn Magazine*, published by ACM, 2008 - present

Invited participant in workshop, *Digitized Content and Issues for Libraries* (2006) sponsored by the American Library Associations's Office for Information Technology Policy

Member, Association of Computing Machinery, 1988-present

Member, ACM SIGCHI, 1988-present

Technical paper reviewer, ACM SIGCHI annual conference, 1993-1995

Occasional reviewer for *Communications of the ACM* and *TechTrends Magazine*